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COMMUNICATIONS

SOME ASPECTS OF VASCULAR CHANGE IN THE FUNDUS OCULI AND OF RETINAL ARTERIO-SCLEROSIS IN PARTICULAR*

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THE changes to be seen on examination of the fundus may be divided, for the purpose of this dissertation, into early and late, although the whole is a continuous progress in which the stages are confluent and intermingled.

The early stages are seen chiefly in the veins and are associated with the pressure exerted on them by the arteries, particularly at the points where these vessels cross each other.

The earliest change is that of general, and not very noticeable, congestion (Fig. 1) (1) of the veins, their diameter being increased throughout their length and their light reflex broader than usual.

The next stage is one which I have not seen described in the literature on this subject and yet is often seen. This condition I named at first "avoidance" (Fig. 1) (2) since, in these cases, the veins which run with the arteries, curve in, as though to cross them, run close for some distance, and then diverge again. Further observation, however, has brought me to the opinion that this is a condition of congestion in which the veins are thereby made longer than usual and are bent towards the artery by their increased length. This, in fact, is the earliest stage of tortuosity of the veins.

* Thesis for the degree of M.B.Cantab.

The further changes concern the points of intersection of veins and arteries and are numerous, and any, or all, may be seen. The earliest alteration is the loss of visibility of the vein (Fig. 1) (3) not only directly under the artery, but for a short distance on each side of that vessel. This is not necessarily a pressure effect, but depends on the increased density of the thickened tunica

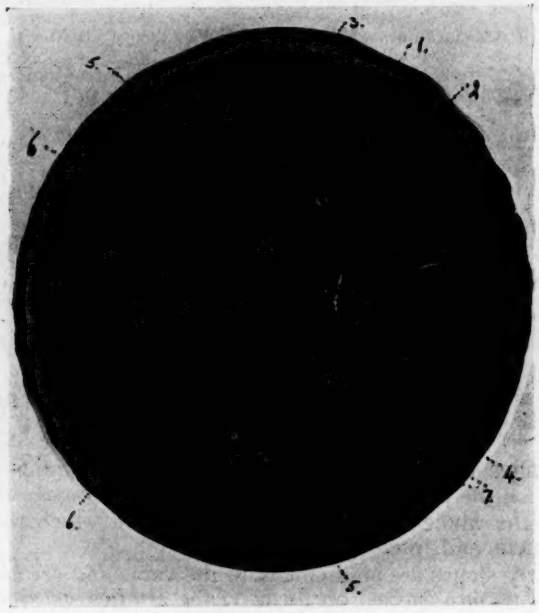

FIG. 1.

Photograph of the pen and ink sketch of the early stages of retinal arterio-sclerosis. The numbers correspond to those in the text. The composite sketch is the same as Plate A.

media of the artery. It is often difficult to distinguish this with certainty from a later condition in which similar disappearance of the vein is seen, but in which there is evidence also of pressure as in (Fig. 1) (4) where there is a slight dilatation of the vein before the artery is reached. It is interesting in this connection to note (Reference: Friedenwald, *Trans. Ophthal. Soc. U.K.*, 1930 and Fig. 3) that the vessel walls of artery and vein at the points of crossing may be, in arterio-sclerosis, fused into one and the same structure, thus explaining the mode of transmission of pressure at these points.

I have been fortunate in being able to demonstrate this fusion in the above photograph from a case of thrombosis of the central vein. The section shows the extreme thickening of the arterial wall; the pressure on the vein below, and the fusion of the two tunica media at the point of pressure is seen in the centre of the plane of contact.

A further change is seen in what is known as "bridging" or "banking" (Fig. 1) (5). In this instance the vein is seen to arch

FIG. 2.

Microphotograph of the Fundus Oculi in section showing a thickened artery compressing the underlying vein. Taken from a case of thrombosis of the central retinal vein with secondary glaucoma.

over or under the artery in a more directly transverse axis to the artery than the general course of the vein, instead of pursuing the even tenor of its way.

A variety of this, which is found to be quite common, although not mentioned in the literature, is a Z formation of the vein (Fig. 1) (6). In these cases there is little or no evidence of bridging, but the vein, while still some distance from the artery, turns abruptly towards that vessel and passes under it with but little evidence of constriction, more at right angles than normally, and proceeds again thus some distance from the artery before it again abruptly resumes the normal direction of the vein.

The mechanical advantages of these changes in a vessel which is becoming compressed at its point of intersection with an artery are obvious, and in general entail a longer course and a more directly transverse crossing.

The final variety of venous distortion is tortuosity (Fig. 1) (7), which is to be seen in advanced cases of retinal arterio-sclerosis and, in minor degrees, may be seen to occur as the early changes which I have described. I would suggest that tortuosity is but the further development of those neglected and slight alterations which I have named "avoidance."

The pathology of these cases may be briefly stated as increased resistance to venous drainage, and the most frequent factor of

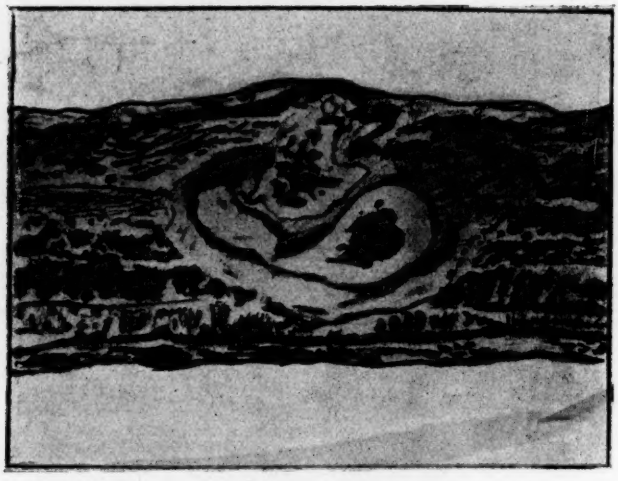

FIG. 3. SECTION OF THE FUNDUS OCULI.

Drawing of microphotograph showing retinal artery and vein in apposition with fusion of the tunica media of the two vessels. From a case of retinal arterio-sclerosis. (After Friedenwald: Doyne Memorial Lecture, 1930, *Trans. Ophthal. Soc. U.K.*, 1930).

importance is that of the thickened and hypertensive arterial wall at the points where vein and artery cross. In addition, the fusion of the vessel walls at this point is a further agent (see Fig. 3).

In the case of the mere disappearance of a vein behind an artery with no alteration of calibre on either side, pressure cannot be deduced, but the thickened wall of the artery is thereby shown (Foster Moore: Medical Ophthalmology, 1925).

The further stages of retinal arterio-sclerosis show themselves in the arteries; these are the later changes. Alterations in calibre are shown in many instances and are various in type. Commonest is the irregular and patchy variation along the course of an artery (Fig. 4) (1), while less obvious, but of equal importance, is a

PLATE A Drawn by Hamblin's for this paper to show the changes described under the heading of the early changes in retinal arterio-sclerosis. For key drawing see Fig. 1.

PLATE B. Fundus Oculi showing the changes in an advanced stage of arterio-sclerosis. For key drawing see Fig. 4.

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general attenuation (Fig. 4) (2) of the arteries which become pale and thread-like. With these must be mentioned "beading" (Fig. 4) (3), in which the blood column is intact although the light reflex is broken and gives the vessel an interrupted appearance.

Alterations in course accompany those of calibre, and various degrees of tortuosity (Fig. 4) (4) may be seen. One type may be

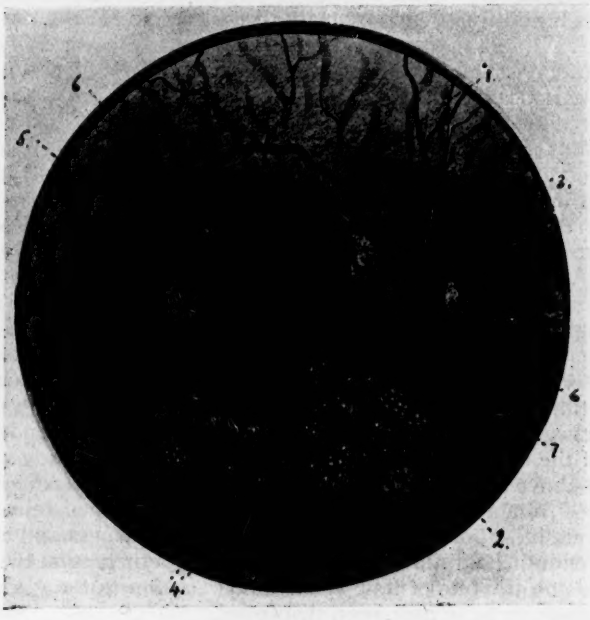

FIG. 4.

Key to composite drawing of Plate B, Fundus Oculi showing the changes in an advanced stage of arterio-sclerosis.

mentioned specifically, that of the small arteries (coursing toward the macula from the superior and inferior temporal arteries), which sometimes assume a very characteristic corkscrew tortuosity (Fig. 4) (5).

Alterations in the light reflex are prominently mentioned in the text-books, and the words "copper-wire" and "silver-wire" are freely used, but observation with the electric ophthalmoscope always gives a bright reflex of silvery or coppery shine, whose intensity must vary with the source of light and every other optical factor before that of the artery wall, and, is in my opinion, a

variable and unreliable sign. Foster Moore states that this sign is of early occurrence, and this may be true if hyaline change of the artery wall be accepted as the underlying pathological change, but if the reflex be due to fibrosis of the tunica media and increase in its thickness, this change must be comparatively late.

Clinically, the sign of silver-wire arteries is found chiefly in advanced cases and is of unfavourable prognosis.

The pathology of the arterial changes is still much disputed, and has been investigated by many. Friedenwald (*Trans. Ophthal. Soc. U. K.*, 1930), speaking of localized variations in course and calibre, states that atheroma is the usual finding. On the other hand, early cases in which compression of the veins is the chief feature may well show only generalized increased thickness of the tunica media. The pathology of the increased light reflex has received many explanations. Gunn held that a diffuse hyaline change in the tunica media was the cause, and in this case might justify the opinion of many authorities, notably Foster Moore, that the copper-wire artery is an early sign. Coats (*Trans. Ophthal. Soc. U. K.*, 1913) considered that thickening of the fibrous tissue and possibly elastic tissue of the tunica media was the cause of the high reflex in the retinal vessels, although he claimed that endarteritis is the commonest lesion of the central artery itself.

Foster Moore has demonstrated the fibrous tissue thickening of the tunica media in a microscopic section of a case which, during life, showed copper-wire arteries, but this was probably an advanced case of the disease.

The above section (Fig. 5) shows admirably a similar condition obtained from a case of thrombosis of the central retinal vein. Other observers have postulated an increase of the thickness and opacity of the endothelial lining of the vessel, and yet others, that the reflex depends on the rate of flow of the blood column in the vessel, but these theories have now been disproved.

Foster Moore considers that the terms "silver-wire" and "copper-wire" are interchangeable and that the change is essentially one of increase of the fibrous tunic of the tunica media. Personally, I intend to apply the term "copper-wire" (Fig. 4) (6) to those arteries showing a definite increase in the brilliancy of the central light streak. The term "silver-wire" (Fig. 4) (7) should be reserved for arteries which show a complete transformation of the wall into fibrous white lines, showing no part of the blood column. This latter change is rarely seen and occurs only in very advanced cases. In the cases I have examined there are very few instances, in spite of the fact that many cases showed other changes indicative of advanced vascular disease.

Other vascular changes in the fundus oculi:—*Thrombosis* of the *central vein* or *artery* of the retina.

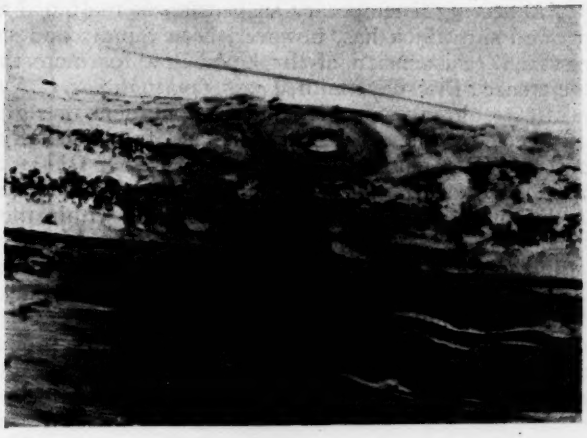

FIG 5.

Microphotograph of the Fundus Oculi in section showing marked thickening of the tunica media of the retinal artery. Taken from a case of thrombosis of the central retinal vein with secondary glaucoma.

These two vascular accidents are purposely considered together, as the great majority of these cases result from the same pathological process. The appearances need but little description as they are well known.

Thrombosis of a major branch of the central artery is more common than of the main trunk itself. In cases where a supplementary artery to the macula arises from the posterior ciliary vessels, this vessel may remain normal, in contrast to the remainder, and the normal colour of the macula, and central vision, are retained.

The *pathology* of this condition is that of vascular sclerosis and endarteritis with partial obliteration of the lumen. This process affects both artery and vein alike, and Coats has rightly remarked that it is almost a matter of chance whether the thrombus occurs in the half-occluded artery or vein. This accident is only of importance in that it shows an advanced degree of arterio-sclerosis. An interesting fact is the extreme rarity of bilateral thrombosis of the artery or vein, in spite of the frequency of arterio-sclerosis in both fundi.

Embolism of the central artery is comparatively rare, and recent investigations emphasize the frequency of an underlying factor of importance in some form of old-standing partial occlusion in the affected vessel. These cases will often give a history, if carefully sought, of prodromal transient attacks previous to the final

calamity, indicating a temporary suspension of the blood flow at the narrowed site which has, however, been rapidly and successfully resumed. Suspension of the blood flow for more than an hour (Reference: Priestley Smith, *Trans. Ophthal. Soc. U.K.*, 1913) will usually result in some permanent impairment of sight over the area affected. These cases are, in fact, fundamentally cases of thrombosis (Reference: Louis Werner, *Trans. Ophthal. Soc. U.K.*, 1913). *True arterial embolism* is most often associated with valvular lesions of the heart and does not come within the scope of this paper.

Exudations seen in the fundus present many questions of extreme difficulty. There is reason to believe that exudates may occur in a number of conditions of varying pathology.

The exudates of diabetic and albuminuric retinitis, probably of similar nature, are more in the nature of degenerative coagulation than true exudate. They form the well-known snow white patches. In chronic cases, no doubt, they depend to some extent on local choroidal ischaemia with consequent atrophy of the retinal cell elements; in acute cases, and particularly in cases of parenchymatous nephritis of rapidly progressive type in the young adult, the retinal vessels have presented no visible change, and these cases undoubtedly involve a toxic factor, presumably blood-borne.

The amount of this toxic factor is a much disputed point, and Barlow (Reference: *Arch. of Ophthal.*, July, 1927) was of the opinion that the cause of the exudate was unrelated to the state of hypertension, while Izod Bennett (Reference: Problems of Nephritis) looks to a pre-renal factor for the cause, both of hypertension and renal vascular sclerosis; but no one has yet pointed with certainty to any such factor, though many chemical constituents of the blood have been blamed in turn.

In the arterio-sclerotic retinitis described by Foster Moore (Medical Ophthalmology, 1925) the exudates are small and guttate, and occur around the vessels in the superficial layers of the retina, and would seem to be associated with the arterio-sclerosis. Again, a toxic factor has been presumed with no very definite evidence to support it. In Barlow's (Reference: *Arch. of Ophthal.*, July, 1927) series of investigations those cases of hypertension without evidence of nephritis showed, in general, little or no exudation. In association with retinal arterio-sclerosis the mode of distribution has resulted in many separate forms being described, but they are manifestations of the same pathological lesion. In retinitis circinata the exudate encircles the macular region on the temporal side and proceeds in crescentic form towards the optic disc.

It would appear, however, that in many cases the exudate is situated in the deepest layers of the retina and often deep to the membrane of Bruch in the choroid itself. In these cases the

exudate will be choroidal in origin and the degeneration of retinal elements secondary to the failure of blood supply therefrom. To this class belong retinitis circinata and senile exudative retinitis, both terms of poor descriptive value, since the lesion is essentially of the choroid primarily and of a degenerative nature. Perhaps chorio-retinitis gives a better indication of its nature.

In acute or sub-acute cases of toxaemia, as in eclampsia, much exudate may be found with little or no change in the vessels beyond a generalized venous congestion, due, primarily, to myocardial intoxication. In cases of chronic arterial disease, however, the arteries will usually be found to be thin and pale with a relatively high light reflex in proportion to their calibre, which latter may also show variations both localized and general.

The condition of *"senile exudative retinitis"* has recently attracted much attention, and some authorities consider this condition to be a manifestation of vascular sclerosis of the choroid.

The two sections above, taken from such a case, demonstrate very clearly the condition of the choroidal vessels and provide strong support for this view. The vascular changes of the choroid seem to be peculiarly separate in incidence of age and progress from those purely of the retinal vessels. Thus the age incidence is in almost all cases above 70 years, and retinal vascular changes are usually insignificant in degree. These cases also very rarely proceed to a fatal vascular accident and are particularly chronic in their slowly progressive course. Total loss of vision is practically never found, in spite of the presence of serious deficiency occurring early in the disease.

From the study of cases of retinal arterio-sclerosis at the Birmingham Eye Hospital, I have come to regard a certain type of retinal exudate as definitely associated with arterio-sclerosis. This exudate is of a dull yellow colour, and may be found in varying distribution and arrangement. One common situation is the margin of the disc, where there may be seen a diffuse yellow exudate fading imperceptibly into the surrounding fundus. Another type shows numbers of small yellow dots, each one of definite outline, distributed over large areas of the retina.

Another exhibition of this exudate, rarely seen, but very striking when found, consists of a number of fine rays radiating from the macula in perfect symmetry. The circle is very rarely seen complete.

This radiating formation round the macula corresponds in type to the "macular star" found in albuminuric retinitis, but is smaller and of a more yellow appearance.

These exudates are often not at all obvious, and, unless specifically sought, may be easily overlooked, especially when appearing only in the guttate form and of small and peripheral distribution.

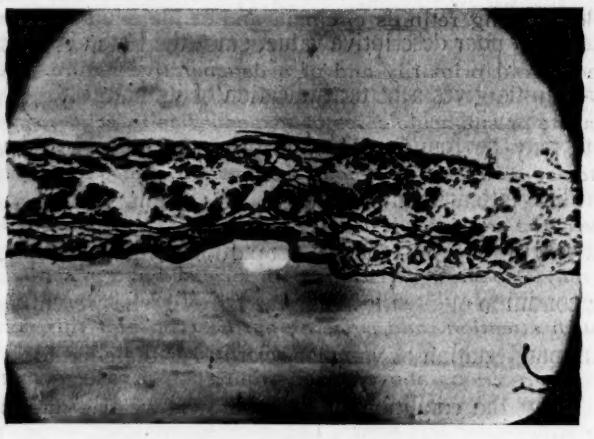

FIG. 6.

Microphotogtaph from a patient with Senile Exudative Choroiditis or "Retinitis," showing the choroid only. Notice the distended veins and the sclerosis of the arteriole in the centre of the section.

FIG. 7.

High power view of the same section showing the condition of the artery in greater detail.

In the sketches (see plates A and B) showing the differences between the early and the late stages, these exudates are vaguely shown and demonstrate the fact that they tone with the colour of the fundus and are not easily apparent, in contradistinction to the exudates of albuminuric retinitis.

The *optic disc* in retinal arterio-sclerosis is usually not much affected until the late stages. In arterio-sclerosis with exudate there is often a characteristic aggregation of exudate round the optic disc. This exudate is very much less defined in outline than that of albuminuric retinitis and extends as a slightly pale yellow mass of irregular outline from around the disc towards the periphery. Similar patches commonly occur also in other parts of the fundus, usually in close association with the larger vessels. Papilloedema is not often seen in these cases and bears no apparent relationship to arterio-sclerosis in the retina.

In advanced degrees of retinal arterio-sclerosis there is often a characteristically waxy pallor of the disc due to ischaemia of the nerve head. This often occurs in cases in which haemorrhages and exudates in the fundus are notably absent and accounts for the slowly progressive loss of vision in some cases which show no such gross retinal lesions. The vessels, however, are very thin and always show advanced arterio-sclerotic changes and the ultimate prognosis for the vision in the affected eye is bad.

The exact pathology of the condition is still obscure, but it has been put forward that the condition is due to changes in the small vessels supplying the nerve trunk and the nerve head, which are for the most part derived from the main trunk of the central artery of the retina.

In attempting to estimate the relation of retinal arterio-sclerosis to general vascular disease, many difficulties arise, since a great many additional and disturbing factors must needs influence the primary issue.

In the series of clinical cases examined I have endeavoured to trace two groups: first, those whose only defect, on first examination, was a vascular lesion of the eye, and, secondly, a group in which there was evidence of a major degree of vascular disease shown in either the cerebral, renal or cardiac systems. Certain aspects of these cases have perforce been neglected, the lack of post-mortem examinations or other pathological material being a serious, but unavoidable, deficiency.

The first group consists of 28 patients who came to my notice in the out-patient department of the Birmingham and Midland Eye Hospital. In these, evidence of vascular changes in the fundus has led to a further investigation; in only one instance was there a past history of a major vascular accident (T. W., aged 55 years). I have tried to show to what extent the changes in the eye have

coincided with some degree of involvement of the vascular system as a whole. In estimating the degree of renal efficiency I have taken, as evidence of early renal failure, a constant low specific gravity of the urine and the presence of hyaline or granular casts, or either separately.

There were also examined a number of cases in which a major vascular accident had occurred, in this instance a group of hemiplegic patients, and in them I have tried to correlate the degree of retinal change and the general condition of the cardio-vasculo-renal system.

Cases of coronary disease and of renal arterio-sclerosis were unfortunately very few. I had hoped to be able to record similar observations on a group of cases showing the signs and symptoms of coronary disease, but these I have had difficulty in finding. I would have preferred this group to have been larger, but material has been scanty. Cases of renal arterio-sclerosis have also been difficult to find.

Extensive enquiries were made to establish a group of cases of essential hypertension and numerous cases were received, but these all showed, on careful examination, a considerable degree of general vascular disease which, while excluding them from their original heading, provides an interesting light on the possibility of their early diagnosis by examination of the fundus oculi, since in these cases the changes were well-marked, though they may well have been cases of pure hypertension at an earlier date.

In investigating the correlation of cases showing a diversity of many vascular changes I have had resort to the notes of private cases from which have been obtained the relative incidence of these changes in some 150 cases. From these have been separated a group consisting of those cases which have died since 1924 in circumstances of vascular interest. Unfortunately, these notes present the difficulty of obtaining accurate data in consulting practice in conjunction with other doctors, and of finding information on specific points at a later date. The difficulty is accentuated since these cases were not specifically examined from the view of this paper, and the notes are therefore probably of well-defined changes only. The difficulty of ascertaining, with any accuracy, the cause of death has led me to an assumption, to some extent unjustified, that in those cases where "sudden death" is the sole information, and where there was reason to anticipate a vascular accident, the cause of death was of this nature.

From the consideration of these cases many points of interest have arisen. I will deal first with the outstanding features of those cases which I examined. The blood-pressure in the group of cases at the Eye Hospital shows a remarkably high average, both of the

systolic and diastolic values, and usually has borne a definite relation to the degree of vascular change seen in the fundus. In these cases some of the lesions have, however, been relatively mild, others have shown advanced vascular changes; in almost all cases the heart has shown no sign of defect, excepting compensatory hypertrophy. On the other hand, the cases of hemiplegia show no consistent range of blood-pressure values, some of the pressures being relatively low. However, it may be pointed out that many of these patients have been bedridden for a number of years and the blood-pressure now is no longer an accurate indication of its state at the time of the lesion many years previously. Similarly, the examination of the heart in cases at the Eye Hospital consistently showed hypertrophy, while those at the Hallam Hospital conveyed the impression of erstwhile hypertrophy, now modified by years of bodily inactivity.

The urine in both groups shows a very considerable percentage of patients in whom renal insufficiency is evident, with no history or other evidence to suggest any cause of renal damage other than vascular changes in the kidneys.

The degree of retinal arterio-sclerosis has shown no constant relation to that found elsewhere in the body, apart from slight cardiac hypertrophy; thus, while in my series of cases at the Eye Hospital, the changes were in most cases well-marked, if early; the hemiplegics did not show any further degree of change except a notably higher proportion of pallor of the optic disc. This is in general accord with the views of most authorities. On the other hand, the presence of retinal arterio-sclerosis is probably always associated with some degree of generalized vascular disease and may provide an earlier indication of this than can be obtained by general examination. In particular there is reason to believe that the retinal changes may furnish a more exact indication of the degree of general disease in the cases of essential hypertension, since in this condition it is the small arteries, of the order to which the retinal vessels belong, which bear the brunt of the disease in its initial stages.

The age incidence of patients has, in the majority of cases, been high and is in those years of life in which some degree of vascular change is to be expected. On the other hand, in my cases at the Eye Hospital, these persons showed no gross evidence of such changes, till submitted to careful examination, which suggests that, in the fundus, vascular disease may be appreciated earlier than by general examination. It is only reasonable to suppose that smaller arteries, under direct observation, should provide earlier evidence of change than larger arteries, or the heart itself, examined by indirect means only.

In my cases other evidence of arterio-sclerosis was, in most

cases, of very moderate degree, and consisted chiefly in elevation of the blood-pressure, the diastolic value being of greater moment than the systolic; of lesser degrees of cardiac hypertrophy; and of early signs of renal inefficiency.

The family history of similar disease is in some cases very striking, and, taking into consideration the frequency with which no reliable information was obtainable, may be said to be of high incidence. This feature is in favour of the hypothesis of a diathesis in disease of the vascular system.

In general, the cases examined have shown no particular coincidence of any one particular feature of retinal vascular change, haemorrhage being the most common. The uniform freedom from exudate in all but the most severe cases, in which there was usually also marked deficiency of the renal function, is very striking.

The disproportion in the sex-incidence is, in my opinion, due to extraneous causes, and is characteristic of all phases of the out-patient department of a hospital.

In reviewing the notes of private patients, certain features stand out. The age incidence again is high—considering the variety of the cases—the average age of 61·93 years, with the lowest instance at 24 years and only four cases under 40 years of age, shows that middle age and senility are the years of these changes. In the fatal cases the average age was 63·0 years, the average period of duration 4·4 years and the age at death averaged 67·4 years.

In the review are tabulated the incidence of certain features, first, in relation to noted retinal arterio-sclerosis, and secondly, where no retinal arterio-sclerosis has been noted. The statistics are appended at the end of this paper. In all these cases the incidence of noted retinal arterio-sclerosis is over double that of those not noted as showing this; the proportion would doubtless have been greater if observation of this feature had been specially carried out. Again, as would be expected, retinal haemorrhage is more often associated with noted arterio-sclerosis of the fundus than not, in the proportion of more than two to one. Retinal degeneration shows an even higher proportion of nearly four to one, a significant fact in view of the vascular origin and progressive course.

The statistics of thrombosis of the central retinal vein and artery do not give as high an incidence of retinal arterio-sclerosis as might be expected, but this may be due to the difficulty of distinguishing the details of the fundus in cases of thrombosis of the vein, and to the tendency to assume the presence of vascular disease of the retinal vessels without specifically noting the changes seen in the case of both venous and arterial thrombosis.

The cases of homonymous hemianopia emphasize the relative infrequency of accompanying retinal arterio-sclerosis, while those

of hemiplegia, cerebral thrombosis, and haemorrhage show the reverse. I would suggest that herein is shown the tendency of the changes of vascular degeneration to be more pronounced in one system of the arterial tree than in another; in the case of homonymous hemianopia changes of the vertebral, basilar, and posterior cerebral vessels, and in the case of "stroke" in the internal carotid system.

It is noteworthy, too, that in cases of renal disease without increase of blood-pressure, such as the early stages of sub-acute parenchymatous nephritis, retinal vascular changes do not as a rule occur, while, when the blood-pressure is raised the retinal changes are usually of an advanced degree. This supports the contention of Izod Bennett (Reference: Problems of Nephritis) that a pre-renal factor is the cause both of the raised blood-pressure and of the renal disease in these cases, and that, in all probability, hypertension precedes renal damage by a considerable period of time.

With regard to the prognosis for life, the presence of arterio-sclerosis in the retinal vessels is not necessarily of serious import, except in so far as there may be co-existent generalized vascular disease.

On the other hand, the presence of vascular sclerosis provides an ever-increasing possibility of the occurrence of thrombosis of a retinal vessel. The prognosis for sight, therefore, should be cautious.

In so far as the retinal arteries form part of the internal carotid system, and lesions are often found localized to this system without severe lesions elsewhere, the possibility of a cerebral vascular accident is to be remembered and should always be kept in mind in giving a prognosis in these cases.

However, the long period of immunity from serious effects achieved in many cases leads one to suppose that, by leading a strictly ordered life, the expectation of life is considerably better than some authorities would admit.

Conclusions

1. Retinal arterio-sclerosis occurs in conjunction with general vascular changes of a similar nature. It is, usually, however, no reliable indication of the degree of generalized arterio-sclerosis. Nevertheless, the examination of the fundi should not be neglected in suspected cases of vascular disease, particularly in early cases, since it may provide a valuable aid to diagnosis.

2. Retinal arterio-sclerosis should be diagnosed, in the early stages, chiefly on changes seen in the veins. Gross changes of the arteries are usually late and only confirm the existence of similar vascular disease elsewhere in the body.

3. The examination of the fundus oculi provides a means of visible investigation of the structure of the smaller arteries which cannot be obtained elsewhere in the body; it is therefore important in all instances of vascular disease.

4. In cases of essential hypertension it is possible that the vessels of the calibre of the retinal arteries, the smaller arterioles, are the first to be affected, and that the changes in retinal vessels in this condition are an early means of diagnosis both of the nature of the disease and its degree.

5. The degree of retinal arterio-sclerosis is not necessarily the same in the two eyes; the major ocular vascular accidents, thrombosis and embolism, are rarely bilateral.

6. The incidence of retinal arterio-sclerosis is higher in cases of "stroke" than in homonymous hemianopia; this may be due to a local preponderance of vascular disease in the internal carotid and basilar arterial systems respectively.

7. In cases of cerebral vascular accidents the heart is found to be normal. Hypertrophy is the only change commonly found and there is no evidence of a failing heart or of gross organic cardiac disease in these cases.

8. In cases showing the early signs of renal inefficiency of vascular origin, the retinal changes may be more easily perceptible than changes in the vascular system in general.

9. Retinal exudate is not a common feature of the arterio-sclerotic fundus and is usually late in appearance and of grave prognosis; the exudate of arterio-sclerosis is to be distinguished from the toxic "exudate" of acute parenchymatous nephritis.

Pallor of the optic disc, on the other hand, is not uncommon when other changes are slight, but is usually associated with very thin arteries.

10. There is reason to believe that certain types of exudate originate primarily in a degenerative lesion of the choroid, to which the retinal changes are secondary. Such changes may occur apart from the changes of retinal arterio-sclerosis. Senile exudative retinitis and retinitis circinata probably belong to this group. The incidence is usually later in life and the prognosis for life surprisingly good.

11. The prognostic significance of retinal arterio-sclerosis is very unreliable owing to the frequently localized extent of the lesion. Its presence should, however, arouse caution and emphasize the importance of a careful general examination of the vascular system and of future observation.

12. The evidence found by these investigations points to the extremely chronic nature of arterio-sclerosis and to the possibility of its occurrence for many years without causing any gross ill-health, and suggests that, if properly treated, it is not so serious

a condition as the literature of recent years would lead one to believe.

I wish to express my thanks to the medical staffs of the Birmingham and Midland Eye Hospital, the General and Queen's Hospitals, Birmingham, and of Hallam Hospital, West Bromwich, for the privilege of making observations on cases under their care, and to the Editors for helpful criticism and revision of this paper.

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Appendix

The first group consists of 28 cases from the out-patient department of the Birmingham and Midland Eye Hospital. The retinal changes cover the whole range of vascular changes described from the earliest to the most advanced stages.

The average age of patients = 57·15 years.

The incidence in decades is as follows: under 40 years (1) = 3·51 per cent.; 40-50 years (4) = 14·20 per cent.; 50-60 years (6) = 21·30 per cent.; 60-70 years (13) = 46·00 per cent.; over 70 years (4) = 14·20 per cent.

In these 28 cases the following table shows the incidence of various complications:—

Retinal arterio-sclerosis	28
Subconjunctival haemorrhage ...	2
Subhyaloid haemorrhage	0
Neuro-retinitis haemorrhagica... ...	1
Retinal haemorrhages	11

Retinal degeneration	2
Thrombosis of central vessels of retina venous 3, arterial 3	6
Waxy pallor of optic disc	8
Homonymous hemianopia	0
Stroke	1
Diabetes	1
Renal disease with high blood-pressure	18
Heart disease	4
Lesions of central nervous system ... Stroke 1, Paralysis of 6th cranial nerve left 1	2
Primary renal disease ... ... ? (Eclampsia)	1
High blood-pressure	23
Relevant family history	7

The second group consists of ten cases of hemiplegia examined at the Hallam Hospital, West Bromwich.

The average age is 68·7 years.

The sex incidence is 4 to 1; females preponderating over males.

Retinal arterio-sclerosis of some degree was observed in all these cases.

The blood-pressure was found very definitely raised in 60 per cent. I have already commented on the reason for this figure being so low.

Heart disease was observed in two cases and a suspicious history of pain and indigestion, possibly of coronary origin, was obtained in a third.

The urinary examination was in many cases deficient; there had been no examination of the centrifugalized deposit for casts. Even so, three cases with certainty, and a fourth doubtfully, showed evidence of renal failure.

Although these were all instances of hemiplegia, only one exhibited homonymous hemianopia.

A family history of relevance was obtained in only two cases, but the age and mental condition of these patients may have contributed to so low a figure.

Other ocular conditions were found as follows:—

Retinal arterio-sclerosis only	2 cases.
Retinal haemorrhages and exudate ...	2 cases.
Lens opacity	3 cases.
Pallor of the optic disc	5 cases.

GROUP I

GROUP I

Name	Age	Sex	Retinal Arterio-sclerosis	B.P.	Radial Artery	Heart	Urine			Other indications of Arterio-sclerosis	Other conditions of Eyes	Family History, etc.
							Sp. gr.	*Alb.*	*Casts.*			
H. S.	60	F.	*Veins:* Congestion. Avoidance. Bridging Nipping. Few Zs. *Arteries:* Thin: Copper wires. Discs: Left pale.	210 / 155	Easily palpable, thick. Volume, poor. Tension, high.	Hypertrophy of left side. Otherwise nothing abnormal.	1008 1006 1010	Haze Haze +	Nil Few granular Few granular	Hypertrophied heart. Urinary specific gravity and casts. Central nervous system nil ad rem.	Left thrombosis central retinal vein. Retinal exudates of arterio-sclerotic type. Left disc pale.	*F.* d. 3 strokes. *M.* d. suddenly cerebral haem. Daughter aet. 40. B.P. normal.
P. W.	66	F.	*Veins:* Congestion. Avoidance. Bridging. Nipping. *Arteries:* Thin: Copper wires. *Discs:* Normal.	145 / 115	Palpable. Moderately thickened Tension, good. Volume, fair.	Slight hypertrophy, otherwise normal.	1012 1014 1016	+ Nil Nil	Nil Nil Occasional cast	Urinary specific gravity. Central nervous system normal.	Nil ad rem.	Nil ad rem.
E. B.	61	F.	Complete series of advanced changes. No beading or silver wire arteries seen.	250 / 146	Palpable. Very hard. Tortuous.	Hypertrophied: left side especially, otherwise normal.	1022 1012 1014	Haze + Haze	Nil Few granular Few granular	Vitreous and retinal haemorrhages. Heart hypertrophied. C.N.S. normal.	Vitreous and retinal haemorrhages.	Nil ad rem.
M. T.	63	F.	*Veins:* Tortuous. Bridging. Avoidance. Zs. *Arteries:* Thin. No haemorrhages.	180 / 100	Palpable. Hard. Volume, poor. Tension, high. Pulse regular.	Hypertrophy. No murmurs.	1008 1008 1014	Haze Haze Haze	Granular Granular Granular	Giddiness. Headaches. No epistaxis.	Cataract: extraction in one eye. Spots of colloidal degeneration around macula.	Rheumatic. *F.* d. apoplexy. *M.* d. chronic Bright's disease. *2B.* d. heart disease.
S. W.	68	F.	*Veins:* Slight general congestion. Avoidance, bridging. Slight compression. *Arteries:* thin: copper wire left fundus only.	150 / 100 = 190 / 110	Palpable. Hard. Volume, fair. Tension, high.	Hypertrophy of moderate degree. Otherwise normal.	1016 1020 1015	+ Haze +	Hyaline and granular Few granular Few granular	Hypertrophy of heart. Casts in urine.	Opaque nerve fibres in left fundus. Haemorrhages. Exudative retinitis. Macular fan left side.	F. d. suddenly ? cause.

Name	Age	Sex	Retinal Arterio-sclerosis	B.P.	Radial Artery	Heart	Urine			Other indications of Arterio-sclerosis	Other conditions of Eyes	Family History, etc.
							Sp. gr.	*Alb.*	*Casts.*			
M. L.	67	F.	Complete series of changes of a moderate degree. Arteries very thin. No haemorrhages or exudate.	160 / 110	Very thick. Tension, fair. Volume, fair.	Partial heart block. No murmurs.	1008 1006 1008	+ Haze Haze	Hyaline Nil Granular	Regular partial heart block: missing 1 in 5. Urine: constant specific gravity and presence of casts.	Right thrombosis of central artery and optic atrophy 8 years ago.	Nil ad rem.
L. W.	52	F.	Complete series of changes of vessels in advanced state of arterio-sclerosis. No haemorrhages or exudates. Discs: normal.	265 / 155 = 245 / 120 = 250-215 / 130	Artery very thick. Volume, poor. Tension, high. ? Pulsus alternans.	Very considerable degree of hypertrophy. No signs of V.D.H. History of rheumatic carditis.	1004 1005 1006	+ + Haze	Nil Nil Nil	Hypertrophy of heart. High blood-pressure. Constant and specific gravity of urine.	Nil ad rem.	? Essential hypertension. Family history nil ad rem.
A. W.	62	F.	Complete series of most advanced type. Retinal haemorrhage and exudate in left; guttate exudate of arterio-sclerotic type in right.	255 / 165	Palpable: thick and tortuous. Tension, high. Volume, fair.	Hypertrophy especially of left side. Extra systoles ? of coronary origin.	1020 1016 1026	+ (pus) + (pus) + (pus)	Few Nil Few	Giddiness. Palpitations. Extra systoles ? coronary in origin.	Retinal haemorrhages: left and exudate. Aneurysms of retinal arteries left. No diabetic retinitis.	Family history. Nil ad rem. Diabetic.
M. P.	70	F.	Venous changes advanced, much tortuosity, copper wire reflex of arteries, tortuous irregular calibre, very thin. *Disc:* Waxy pallor of each side.	190 / 70	Thick and tortuous. Volume, large. Tension, fair.	Very marked hypertrophy. Aortic regurgitation and secondary mitral incompetence.	1004 1006 1006	Nil + Haze	Few granular Granular Granular	Headaches (? cardiac in origin). Indigestion (? cardiac in origin).	Thrombosis of left central vein. Multiple haemorrhages.	Nil ad rem.

			for of each side.									
S. H.	69	F.	Slight degree of retinal arterio-sclerosis. *Veins:* Some congestion: few indications of pressure. Arteries show slight narrowing.	150 105	Thick and firm. Tension, weak. Volume, large. Pulse regular.	Hypertrophy: rate and rhythm regular, no murmurs	1002 1009 1016	Nil Nil Nil	Occasional hyaline Nil Occasional	Moderate hypertrophy of heart. Otherwise none.	Retinitis circinata.	Nil ad rem.
C. C.	63	F.	Moderate degree of retinal arterio sclerosis. Venous congestion, bridges, Zs. *Arteries:* Few copper wire reflex.	135 75	Thin, palpable, firm. Volume, fair. Tension, fair.	Slight hypertrophy, mostly of left side. Otherwise normal.	1016 1012 1012	Nil Nil Nil	Occasional granular Occasional granular Nil	Paralysis of left sixth cranial nerve (? vascular origin).	Paralysis of left abducent nerve and diplopia.	*F.* d. heart attack. *M.* d. paralysis (? stroke).
C. M.	69	F.	*Veins:* Congestion, slight tortuosity, avoidance, Zs., bridging, nipping. *Arteries:* Thin, straight, copper wires. No haemorrhages or exudate. *Discs:* Normal.	220 140	Palpable, moderately thickened. Tension, high.	Hypertrophy of moderate degree. Otherwise normal.	1022	Haze (pus)	Occasional granular	Hypertrophy of heart. High blood pressure. No other evidence.	Nil ad rem.	Nil ad rem.
A. D.	67	F.	Moderate degree of retinal arterio-sclerosis. Venous changes marked: *Arteries:* thin but no alteration of calibre.	170 120	Artery not much thickened. Pulse irregular in force and rhythm.	Hypertrophy, slight and mostly of right side. ? Auricular fibrillation. No murmurs definite.	1003 1002 1010	+ + + (pus)	Hyaline and granular Nil Few casts.	Pain in chest. ? Of coronary type. Dyspnoea.	Retinal haemorrhages and macular degeneration of right fundus. Discs: slightly pale.	Nil ad rem. No history of rheumatic carditis.

Name	Age	Sex	Retinal Arterio-sclerosis	B.P.	Radial Artery	Heart	Urine			Other indications of Arterio-sclerosis	Other conditions of Eyes	Family History, etc.
							Sp. gr.	*Alb.*	*Casts.*			
A. T.	48	F.	Right fundus: within physiological limits of normality. Left fundus: early changes in veins congestion, bridging avoidance. Z's.	115 / 65	Normal.	Normal.	1006 — 1010	Haze Haze Haze	Hyaline and granular Granular Granular	None.	Optic neuritis. Right: chronic glaucoma.	Nil ad rem.
A. H.	47	F.	Every possible change of the vessels. Alterations in calibre of veins and arteries marked. Beading of arteries.	230 / 160	Palpable, thick and firm. Volume. fair. Tension, fair.	Considerable degree of hypertrophy, especially of the left side. Otherwise normal.	1016 1010	Haze Haze	Granular Granular	Presence of casts in urine. Hypertrophy of heart and high blood pressure.	Only retinal arterio-sclerosis. No haemorrhages or exudate. Discs normal.	? Essential hypertension. —— Family history nil ad rem.
L. L.	36	F.	Very slight changes. Congestion of veins: no alteration of calibre: a few examples of bridging. No haemorrhages or exudates.	140 / 68	Regular and rapid. Volume, fair. Tension, poor.	Very slight hypertrophy. Otherwise normal.	1006 1012 1014	Nil Haze Haze	Nil Nil Nil	Nil.	Glaucoma—left eye.	*F.* d. stroke.
S. D.	59	F.	Advanced retinal arterio-sclerosis with both venous and arterial changes. Guttate arterio-sclerotic exudate in each eye. Haemorrhages each eye. *Discs:* Waxy pallor.	240 / 160	Firm and full. Volume, large. Tension, high.	Hypertrophy marked. Otherwise normal.	1005 1008 1010	+ + + +	Granular Granular Granular	Hypertrophied heart. Casts in urine. Central nervous system normal.	Retinal haemorrhages. Macular fan of exudate in left eye. —— Beading of artery in this case.	Nil ad rem. Sister normal.

			Discs: Waxy pallor.									
C.	55	F.	*Veins:* Compression, avoidance and slight tortuosity. Bridging, nipping. *Arteries:* Copper wires. *Discs:* Normal.	150 — 90 176 — 96	Palpable, firm but not tortuous Tension, high. Pulse, regular.	Slight hypertrophy. Otherwise normal.	1016 1003 1014	Nil Nil Nil	Occasional Hyaline Nil Occasional	None.	Exudative retinitis.	Nil ad rem.
L. B.	48	F.	Complete series of changes in vessels, except no beading and no silver wires seen. Few small haemorrhages.	250 — 140 220 — 120	Palpable and thick. Volume, poor. Tension, high. Pulse—regular.	Hypertrophy of left side especially; aortic 2nd sound accentuated.	1006 1001 1006	+ Haze Haze	Granular Granular Nil	Hypertrophy of heart. Low specific gravity and casts in urine. Central nervous system normal.	Few small retinal haemorrhages and small amount of scattered yellow exudate; subconjunctival haemorrhages.	Nil ad rem.
J. M.	43	F.	Very advanced degree of changes in vessels. The right fundus has only a few small retinal haemorrhages, the left many. Alterations of the calibre of the arteries marked; no beading.	255 — 155	Thick and firm. Tension, fair. Volume, large.	Marked hypertrophy, of left side especially. Otherwise normal. Dyspnoea and cyanosis.	1018 1012 1006	+ Haze Haze	Hyaline Hyaline Nil	Hypertrophy of heart. Presence of casts in urine. High blood pressure.	Thrombosis of left superior temporal branch of central vein. Macular fan, left. Retinal haemorrhages.	Eclampsia and nephritis. (? stroke with temporary affection of speech).
J. M.	73	M.	Moderately advanced degree of change in both arteries and veins. Venous pressure changes prominent. Copper wire arteries. Right disc pale.	180 — 145 160 — 100	Thick, not tortuous. Volume, moderate. Tension, moderate.	Hypertrophy. Otherwise normal.	1002 1012 1008	+ Nil Nil	Hyaline Occasional granular Nil	None. Central nervous system normal.	Cataract each eye, operated on. Right optic disc atrophic from thrombosis of central artery. Macular haemorrhages.	Nil ad rem. Wassermann negative.

Name	Age	Sex	Retinal Arterio-sclerosis	B.P.	Radial Artery	Heart	Urine			Other indications of Arterio-sclerosis	Other conditions of Eyes	Family History, etc.
							Sp. gr.	*Alb.*	*Casts.*			
T. W.	55	M	Veins, congestion and slight tortuosity, avoidance, bridging, nipping. Copper wire arteries. Both discs show slight waxy pallor.	150 — 95 160 — 100	Thick and hard, slightly tortuous. Volume, poor. Tension, poor.	Not enlarged. No murmurs, First sound at apex slightly accentuated.	1016 1018 1018	Nil Nil Nil	Nil Nil Nil	Left hemiplegia 1926. Left hemiplegia 1930. Affection of speech 1930. (? vascular origin). Giddy. Has fits.	No retinal haemorrhage or exudate. No vitreous opacities. Irregular calibre of vessels.	No rheumatic fever. No venereal disease. Nil ad rem.
H. MacD.	59	M.	Advanced changes in left fundus. Irregular calibre of both arteries and veins. Copper wire arterial reflex prominent. Few small haemorrhages. Discs pale.	200 — 146	Palpable, very thick and tortuous. Volume, fair. Tension, high.	Hypertrophy, especially of left side. Otherwise normal.	1016 1012	Nil Nil	Nil Nil	Hypertrophy of heart. Constant specific gravity of urine. Thrombosis of central retinal artery.	Thrombosis of right central artery of retina 1912. Excision right eye 1930.	Nil ad rem. Oral sepsis. Wassermann negative.
T. B.	62	M.	Advanced changes in each eye; veins show congestion, avoidance, bridging, nipping. Arteries thin, copper wire reflex. Waxy pallor of discs. Haemorrhages and exudate.	160 — 106 192 — 126	Palpably thick and tortuous: not hard. Volume, moderate. Tension, moderate.	Slight hypertrophy. No murmurs. Otherwise normal.	1020 1002 1018	Haze + +	Granular Nil Nil	Hypertrophy of heart. Central nervous system normal. No other evidence.	Retinal haemorrhages and exudate. Patches of oedema.	*M*: d: suddenly ? cardiac. Patient asserts a rheumatic history.
S. H.	63	M.	Moderate chan-	165	Thickened.	Heart enlarged,	1016	+	Nil	Constant speci-	Retinal arterio-	Nil ad rem.

S. H.	63	M.	Moderate changes: chiefly of venous congestion and pressure by crossing arteries. Arteries slightly narrow. ?copper wire reflex.	165 / 110	Thickened. Volume, fair. Tension, poor.	Heart enlarged, secondary weakness due to malignant cachexia.	1016 1016 1030	+(pus) +(pus) +(pus)	Nil Nil Few granular	Constant specific gravity of urine. Old hypertrophy of heart.	Retinal arteriosclerosis only. No haemorrhages or exudates.	Nil ad rem. Patient has new growth of colon.
S. J.	74	M.	Moderately advanced degree of change in both arteries and veins. Venous congestion and compression. Copper wire reflex of arteries. Some guttate arteriosclerotic exudate of retina.	185 / 100	Thick, tortuous. Volume, moderate. Tension, moderate.	Considerable hypertrophy. Otherwise normal.	1008	Trace	Few granular	Hypertrophy of heart; casts in urine.	Senile exudative retinitis. Diffuse old choroiditis. Bilateral extraction (cataract). Right disc pale ? normal.	Nil ad rem. *F.* d. 90. *M.* d. 98.
G. B.	72	M.	Moderate degree of arteriosclerosis affecting chiefly veins which show congestion. Bridging, nipping, and slight tortuositv. Arteries show a few places with copper wire reflex.	136 / 86	Palpable, only slightly thickened. Volume, normal. Tension, normal.	No hypertrophy, or very slight. Nothing abnormal found.	1024 1026 1022	Nil Nil +(pus)	Occasional Hyaline Nil Nil	None.	Subconjunctival haemorrhage.	*F.* d. suddenly (? cause).
C. H.	69	M.	*Veins:* Avoidance, congestion, tortuosity, bridging, nipping, changes of calibre. *Arteries:* Thin, irregular calibre, generally narrow copper wire reflex.	196 / 110	Considerably thickened. Volume, fair. Tension, high.	Hypertrophy chiefly of left side.	1015 1006 1007	+ + +	Granular Granular Granular	Hypertrophy of heart. Granular casts in urine. Central nervous system normal.	Retinal haemorrhage in each eye. Papillitis in each eye, but no oedema. Few guttate patches of exudate.	Nil ad rem.

GROUP II

Name	Age	Sex	Retinal Arterio-sclerosis	B.P.	Radial Artery	Heart	Urine		Other indications of Arterio-sclerosis	Other conditions of Eyes	Family History, etc.
							Sp. gr.	*Alb.*			
M.	53	F.	Moderately advanced degree of change. All the changes of venous congestion and compression. Copper wire reflex of arteries.	160 — 95 180 — 100	Thick and firm. Volume, moderate. Tension, moderate.	Moderate hypertrophy.	1010 1020	(Pus) (Pus)	Right hemiplegia, 2½ years.	Retinal arterio-sclerosis only.	*F.* d. suddenly (? cause).
J.	69	F.	Venous compression, bridges, Z's. *Arteries:* Copper wire reflex. Retinal haemorrhages and exudate of arterio-sclerotic type. Optic discs pale.	220 — 140 190 — 110	Thick: hard. Volume, poor. Tension, rather high.	Hypertrophy, especially left side.	1015 1015	Haze Haze	Right hemiplegia, 6 months.	Retinal haemorrhages and exudates.	Nil ad rem.
R.	84	F.	*Veins:* Avoidance, compression, bridges, Z's, slight tortuosity. *Arteries:* Bit narrow. Reflex normal.	125 — 85 100 — 70	Very thick and tortuous.	Feeble heart sounds due to emphysema; moderate long standing hypertrophy.	1015 1015	Nil Nil	Left hemiplegia 6 years.	Right lens opacity. Left corneal opacities.	*M.* d. 3 strokes.
M.	58	F.	*Veins:* Avoidance, compression, bridges, Z's. *Arteries:* Copper wire reflex.	210 — 110 180 — 90	Palpable, very hard. Tension, high. Volume, poor.	Considerable degree of hypertrophy.	1020 1015	Haze Haze	Left hemiplegia (? years).	Retinal arterio-sclerosis only.	Nil ad rem.
L.	66	F.	Moderate degree of change chiefly of venous congestion and compression. Increased reflex of arteries, especially in left fundus.	150 — 80	Thickened. Tension, moderately raised Volume, moderately raised.	No very marked abnormality; no obvious hypertrophy.	1015	Nil	Left hemiplegia (? years).	Right complete lens opacity.	Nil ad rem.

			Increased reflex of arteries, especially in left fundus.		artery raised.	trophy.					
H.	82	F.	Whole series of changes of moderate degree shown by veins. Arteries show copper wire reflex. Disc pale.	280–330 80 ?	Pulse feeble, irregular. Tension, poor. Volume, variable. Pulsus alternans.	Hypertrophy considerable. Heart block.	1010 1010	Nil Nil	Right hemiplegia, 12 years. Left hemianopia.	Left complete opacity of lens.	Nil ad rem.
W.	78	F.	*Veins:* Avoidance, congestion, compression, Z's, bridges, tortuosity. *Arteries:* Copper wire reflex. Retinal haemorrhages and exudate.	210 55	Water-hammer pulse. Artery thickened. Volume, very large.	Hypertrophy. Aortic regurgitation. Mitral incompetence.	1015 1018	Nil Nil	Right hemiplegia, 18 months.	Haemorrhages and exudate of retina, the latter of arteriosclerotic type.	Nil ad rem.
H.	69	F.	*Veins:* Tortuous, advanced stages of compression at arterial crossings. *Arteries:* Very thin.	220 110	Much thickened. Hard and tortuous.	Hypertrophy. Otherwise normal.	1010	+ (Pus)	Right hemiplegia, 4 years. Anginoid pains. Indigestion. (? cardiac origin).	Right optic disc pale.	Nil ad rem.
W.	70	M.	*Veins:* All the venous changes of congestion and compression. Irregularity of calibre. *Arteries:* Copper wire, calibre irregular.	160 110	Moderately thickened. Volume, slightly raised. Tension, slightly raised.	Hypertrophy moderate. Double second sound at aortic base.	—	—	Right hemiplegia, 8—10 years.	Waxy pallor of disc in each side.	Nil ad rem.
C.	58	M.	*Veins:* Avoidance, bridges, compression, Z's, slight tortuosity. *Arteries:* Very thin, irregular calibre, copper wire reflex. *Discs:* Both definitely show waxy pallor.	160 85	Thickened. Volume, fair. Tension, fair.	Slight hypertrophy. Otherwise normal.	1022	Nil	Left hemiplegia, 6—7 years.	Both optic discs show distinct waxy pallor.	Nil ad rem.

The third group consists of a review of the notes of over 150 cases from consulting practice. I have already mentioned the difficulties and disadvantages of this review, but there appeared no other way in which a sufficiently large number of cases might be studied to provide any reliable index of the proportion of complications.

A sub-group consists of cases which have since terminated fatally in circumstances suggesting disease of the cardio-vascular system. The following table classifies the main points:—

Number of cases—152.

(*a*) Number of cases alive—80.

(*b*) Number of cases dead—72.

(I) With retinal arterio-sclerosis—69.
Without noted arterio-sclerosis—11.

(II) With retinal arterio-sclerosis—57.
Without noted arterio-sclerosis—35.

Complications of group (*a*)—those still alive.

	With retinal arterio-sclerosis.	Without noted retinal arterio-sclerosis.
Subconjunctival haemorrhage	3	0
Subhyaloid haemorrhage	1	0
Neuro-retinitis haemorrhagica	1	0
Retinal haemorrhage	19	2
Retinal degeneration and exudate	15	4
Thrombosis of central artery or vein	6	4
	3 venous, 3 arterial	3 venous, 1 arterial
Homonymous hemianopia	5	4
Stroke	6	0
Diabetes	3	1
Renal disease with high blood-pressure	5	0
Heart disease	3	1
	1 coronary	mitral
Raised blood-pressure	20	1
Pallor of optic discs	6	0

Complications of group (*b*)—those dead.

	With retinal arterio-sclerosis.	Without noted *retinal* arterio-sclerosis.
Subconjunctival haemorrhage	*1*	*5*
Subhyaloid haemorrhage	0	3
Neuro-retinitis haemorrhagica	*2*	*3*
Retinal haemorrhage	15	13
Retinal degeneration and exudate	*6*	*2*
Thrombosis of central artery or vein	9	5

	With retinal arterio-sclerosis.	Without noted retinal arterio-sclerosis.
Homonymous hemianopia ...	1 ...	... 5
Stroke	13? ...	... 5
Diabetes	2 ...	... 4
Renal disease with high blood-pressure	4 ...	... 1
Heart disease	5 ...	... 10?
Raised blood-pressure	16 ...	... 3
		2 homonymous, hemianopia.
Waxy pallor of disc	15 ...	... 4
Sudden death, ? cause	11 ...	... 8

The sum total of these two groups results in the following tables:

	With retinal arterio-sclerosis.	Without noted retinal arterio-sclerosis.
Total number of cases	106 ...	... 46
Subconjunctival haemorrhage ...	4 ...	... 5
Subhyaloid haemorrhage ...	1 ...	... 3
Neuro-retinitis haemorrhagica ...	3 ...	... 3
Retinal haemorrhage	34 ...	... 15
Retinal degeneration and exudate	21 ...	... 6
Thrombosis of central artery or vein	15 ..	... 9
Homonymous hemianopia ...	6 ...	... 9
"Stroke"	19 ...	... 5
Diabetes	5 ...	... 5
Renal disease with high blood-pressure	9 ...	... 1
"Heart disease"	8 ...	... 9
Raised blood-pressure	36 ...	... 4
Pallor of optic disc	21 ...	... 4

The fourth group consists of a few cases examined at the General Hospital, Birmingham, with the object of correlating coronary disease and retinal arterio-sclerosis. These have been in many ways unsatisfactory, in so far as diagnosis of the coronary lesion has been subject to human error; in only one case has an electrocardiographic examination substantiated the diagnosis. This group also includes a very interesting example of primary renal disease in a young adult, in which changes in the retinal vessels were conspicuously absent, in spite of a considerable degree of albuminuric retinitis with exudate. Another case, that of a middle-aged woman, was complicated by a history of gall-bladder colic; in view of the comparatively low blood-pressure in this case I was not certain of the correctness of the diagnosis of angina pectoris. The case of bundle branch block was of extreme interest in that the fundus showed an advanced degree of arterio-sclerotic change without the appearance of either exudate or haemorrhages.

GROUP IV

Name	Age	Sex	Retinal Arterio-sclerosis	B.P.	Radial Artery	Heart	Urine	Other indications of Arterio-sclerosis	Other conditions of Eyes	Family History, etc.
F. H.	61	M.	*Veins:* Not congested, but showing all the signs of compression at arterio-venous crossings. Whole fundus slightly pale. *Arteries:* Very thin, irregular calibre, copper wires. No haemorrhages or exudates. Discs normal.	200 / 155	Very firm and thick. Volume, poor. Tension, high.	Moderate hypertrophy. Auricular fibrillation giving way to bundle branch block. Split ventricular complex, etc., on electrocardiograph. Split apex beat.	Specific gravity constantly between 1018 and 1020 on eight occasions. Albumen always present.	Condition of heart. Constant specific gravity of urine. Retinal vessels. Radial artery.	Nil.	Nil ad rem.
W. J.	62	M.	*Veins:* Slight congestion and tortuosity. Venous compression by arteries, bridges, Z's, nipping. *Arteries:* Thin and copper wire reflex, no beading. No haemorrhages or exudates. Discs pale.	180 / 110	Easily palpable, thick and nodular. Volume, moderate. Tension, high.	Extreme hypertrophy, especially of left side, possibly due to high altitudes. 2nd sound at aortic base accentuated.	1010 Alb. + / 1012 Alb. +	No history of other disease accounting for urinary failure. (?) arterio-sclerotic kidneys. Signs of incipient uraemia.	Nil.	Nil ad rem. / Spent 3 years in Andes at high altitude.
E. P.	59	F.	*Veins:* No congestion of noticeable degree. Few bridges, no nipping. *Arteries:* Narrow, no copper wires.	140 / 100	Palpable, thickened and firm. Tension, high. Volume, poor.	Slight hypertrophy. Patient very obese. Otherwise no abnormality found.	1008 Alb. haze	History of fairly typical attacks of anginoid pain.	Nil.	*M*d. 2 strokes. / Cholecystectomy.
N. T.	29	M.	No evidence of arterio-sclerosis in the fundi, except very slight congestion of the veins generally.	190 / 126 / 165 / 100	Palpable, not much thickened.	Slight enlargement, sounds tapping in quality. Otherwise nothing abnormal.	Specific gravity constantly between 1009 and 1004 on fifteen occasions. Albumen always present. No	Raised blood pressure. Constant specific gravity of urine. Otherwise nothing.	Albuminuric retinitis with exudates. (Subacute nephritis).	Nil ad rem. / Scarlet fever. / Blood urea 350–220 mgs. %.

A SERIES OF THIRTY-ONE CASES OF RETINAL DETACHMENT TREATED BY DIATHERMY

BY

E. F. KING

LONDON

THE following is a brief survey of the operations performed for detached retina at Moorfields Eye Hospital during the last three years and an analysis of 31 cases treated by diathermy during my last three months there as House Surgeon, from August to October, 1932.

Gonin's method of cautery puncture for detachment was begun at Moorfields in December, 1929, and the results were analysed by Shapland, who showed that 27·5 per cent. of the first 200 cases were cured, *i.e.*, left hospital with a full field and no detachment visible. None of these cases had been subjected to any previous detachment operation, nor was any selection exercised and every case which offered the smallest hope of improvement was treated. I have no figures of relapse but this occurred in a relatively small number of cases and it was not felt that the operation should be discredited on this account. It was, however, appreciated that cautery puncture was a drastic operation, necessarily traumatising the vitreous in cases where it was, frequently, already degenerate, and the scarring produced was often excessive, with the result that, though the original hole was closed, a new one was torn in the neighbourhood. Further, in this operation the electro-cautery must "hit off" the retinal tear with absolute precision, which requires extremely accurate localization of the hole, a procedure beset with many difficulties, particularly when the hole is situated on the top of a balloon detachment and at some distance from the periphery of the fundus. For these reasons the Guist operation of multiple trephining with application of solid caustic potash to the exposed choroid was introduced. This has two manifest advantages over Gonin's operation, first, that the field of operation is outside the vitreous chamber, and secondly, a diffuse field of chemical choroiditis is produced, so planned that the estimated position of the tear, when the retina is flat, will be at its centre; in this way the importance of extreme accuracy in localization of the hole, which must contain, in the final instance, an element of luck, is minimised.

Black showed that in the first 30 cases treated by Guist's method, which had not had a previous cautery puncture, 45 per cent. were cured. Here again no selection was exercised and the operation performed in every case that was not entirely hopeless. It is

notable that in four of these cases no hole was found, the caustic potash being applied to each quadrant of the globe in which detachment was present. Unfortunately, these encouraging results were not maintained, and in the following 42 cases, in which no operation had been done before, there were only 21·4 per cent. of cures and 23·8 per cent. of cases showing improvement, *i.e.*, enlargement of the field though some detachment was still visible; a large proportion of the latter would, of course, be expected to relapse. There appear to have been three cases cured by this operation which had previously been unsuccessfully treated by cautery puncture.

The advantages of the method of diffuse caustic cauterization of the choroid over that of localized thermal cauterization seemed clear, but it was found that the reaction in the eye was often severe, leading to pronounced vitreous haze and opacities. On three occasions in the series of 72 cases a large, opaque, swollen mass appeared in the fundus after operation, presumably due to thrombosis of a vortex vein, and though this largely subsided in the course of time the function of the eye was virtually lost. Moreover, the technical difficulties of multiple trephining of the sclera, often at a considerable distance from the limbus, are very great, for the risk of perforation of the choroid is always present, after which completion of the operation is almost impossible, and it seems doubtful, on this score alone, if the operation will ever attain widespread popularity.

There appear to be two lines of treatment of detached retina by diathermy current corresponding in principle with the Gonin and Guist operations. Weve of Utrecht, like Gonin, aims at sealing the hole in the retina itself. For localization of the hole he uses a "substitution" method. With the head of the patient immobile in a rest, an ophthalmoscope, carried on a rotating arm, is focused on the hole and clamped. The patient is removed and a frosted glass globe of approximately the same dimensions as the eye in question introduced in the exact position of the eye itself. The beam from the ophthalmoscope can be picked up at points where it enters and leaves the globe, the latter point giving the relative position of the hole in the eye. Two limbs of an adjustable tripod are placed at 3 o'clock and 9 o'clock on the "limbus" of the substituted eye, the third limb rests where the beam from the ophthalmoscope is picked up; the tripod is clamped and transferred to the patient's eye at operation—two limbs being placed at 3 o'clock and 9 o'clock on the limbus and the third limb indicating the mark in the sclera where the position of the hole is estimated. I find it difficult to believe that this somewhat complicated method will give better results than our plan of marking at the limbus, with Indian ink, under direct vision with an electric ophthalmoscope, the meridian

in which the hole is situated, and estimating in disc diameters the distance of the hole in that meridian from the most anterior part of the fundus visible. Having marked on the sclera the estimated position of the hole, Weve proceeds to puncture the sclera and choroid and to reach the retinal hole, using a fine blunt needle electrode and a uni-polar diathermy current of 40 to 50 milliampères (the indifferent electrode is not employed); the needle first engages the sclera, the current is then turned on when, with the minimum of pressure, it sinks into the eye. An ophthalmoscopic examination is now made; to facilitate this, as the cornea so readily becomes dry under cocaine, he keeps a corneal contact lens (11 mm. diameter and 7·5 mm. radius of curvature) in position throughout the operation; this is readily adjusted before each examination. A white, fluffy, very obvious area of coagulation is seen and its position in relation to the hole noted as a guide to further punctures. A series of punctures is made in this way until the entire margin of the tear is coagulated, a fundus examination being made after each. Sub-retinal fluid is only lost gradually throughout the operation but it must be ensured, finally, that sufficient has been evacuated to bring the retina approximately in contact with the choroid. This operation is beautiful in its precision and it is remarkable the ease and certainty with which a retinal hole can be closed under direct vision. It would, however, seem to share with Gonin's operation the objection of plunging the cautery into the vitreous itself, surely an undesirable practice in any case of detachment, though the diathermy current is obviously a more readily controlled method of producing coagulation than the electro-cautery.

I understand that for cases of oral tear, or so-called anterior retinal dialysis, Weve used a method of superficial diathermy cauterization of the choroid without puncture similar to that employed in the cases to be described.

The second method of treatment by diathermy current, and the one which was used solely in this series of cases, was described by Larsson of Stockholm. It is analogous to the Guist operation in that it aims at producing a diffuse area of choroiditis without any active interference within the vitreous. It is claimed that, if this area of induced choroidal inflammation is so placed that when the sub-retinal fluid is evacuated the retinal hole lies upon it, the communication between the pre-retinal and sub-retinal spaces will be closed and the detachment cured. The only essential difference being that Guist, of course, uses caustic potash to produce the choroidal reaction while here the diathermy current is employed to produce a similar effect.

Whilst acknowledging the fundamental importance of Gonin's observation with regard to the retinal tear, Larsson considers that

the hole is usually surrounded by an area of retina which is thin and of lowered resistence, predisposing to the formation of new holes, an observation which can be supported by an examination of the neighbourhood of the hole in most detachments. He suggests that to obtain a cure, adhesion of the retina to the choroid must be obtained not only at the margin of any hole or holes but for a considerable area around. For this reason he considers that accurate localization of the hole no longer has the same value, though, obviously, discovery of a hole is still of prime importance to indicate the site of operation. We have continued to mark out the hole under direct ophthalmoscopy, as for cautery puncture, for without it at operation the globe is liable to become twisted and thereby accurate bearings lost.

I understand that Safar in Vienna is using a small needle electrode carrying a diathermy current, which perforates the sclera and engages in the choroid, producing there localized foci of inflammation. It is maintained that this method is more deliberate than the diffuse cauterization and is less likely to cause choroidal infarction, a complication which has not so far been met with at Moorfields.

The Operation

Very little discomfort is experienced and no general anaesthetic or narcotic is usually necessary, though hyoscine and morphine or nembutal may be used. The machine used is a standard diathermy apparatus supplied by Messrs. Schall. There are technical difficulties in measuring a diathermy current rapidly, for the ampèremeter used for the currents employed in general diathermy work is dependent on the expansion of a wire to varying temperatures and takes an appreciable time to adjust. Further, such a measurement, while satisfactory for reading in ampères, is of less value for the small currents—up to 100 milliampères—which we employ.

I undersand that it is possible to obtain a milliampèremeter which registers more rapidly, dependent on a secondary current generated at a thermo-couple in the main circuit, but I have not seen this used. To overcome these difficulties Larsson estimates the current by placing the indifferent and active electrodes in contact before the operation is begun, the current is turned on and regulated so that a reading of 0·75 to 1 ampère is obtained; the indifferent electrode is now bandaged to the leg or arm and the active electrode attached to that used on the eye itself.

Larsson uses as his active electrode a fine, bent wire at the end of which is a ball 0·66 mm. in diameter. Messrs. Weiss

made this for us but it seemed unnecessarily pliable so we use a platinum wire of the same diameter, 1·5 inches long, bent in the middle at 130°. A vulcanite speculum is useful since if the electrode touches a metal speculum the patient experiences some pain. A sub-conjunctival and sub-Tenon's capsule injection of novocaine and adrenalin is given in the neighbourhood of the hole; a guide-stitch, knotted at one end, is passed through the limbus at the ink mark diametrically opposite the hole. A flap of conjunctiva and Tenon's capsule is dissected up and the edges of the muscles isolated in that quadrant of the globe where the hole is situated; the guide-stitch is threaded through Desmarre's retractor and drawn taut so that it crosses the centre of the cornea. Along this guide the estimated distance of the hole from the limbus is measured off with calipers (allowing 8 mm. in an emmetrope and 9 mm. in a myope as the distance from the limbus to the most anterior portion of the fundus visible and 1·5 mm. for each disc diameter of measurement in the fundus). The surface marking of the hole having been ascertained it is marked on the sclera by one or two turns of a 1·5 mm. trephine; this spot is to be the centre of the cauterized area. It is important to remove all episcleral tissue and to get the field of operation quite dry; bleeding from fine vessels can be stopped readily by touching them with a small metal rod, *e.g.*, a lacrymal probe, heated almost to red heat in a spirit flame. To obtain good access to the field of operation a traction stitch through the sclera just outside the limbus is useful. Having again identified the groove made by the trephine, which indicates the position of the hole, cauterization is commenced at this spot. The electrode must be in contact with the sclera before the current is turned on; five seconds is allowed and the current is then turned off before the electrode is removed. The required reaction is soon learnt; there is an immediate flattening and drying of the sclera in the neighbourhood of the electrode and a greenish, brown ring appears around it. It is well to start with a low current (0·75 ampère with the active and indifferent electrodes in contact) and to increase it gradually, if necessary, for it is quite easy, if too strong a current is employed, to perforate the sclera and choroid at the first application; further, the reaction to a given current varies with each individual patient. This is repeated over the required area of the sclera, about 1·5 mm. interval being allowed between each application. The distribution of the cauterization will depend on the size and shape of the hole and should cover widely the estimated margins of the hole and any thin areas of the retina which were detected. An oral tear or anterior retinal dialysis will, of course, only require a curved area of cauterization starting and ending in the ciliary region and encircling the tear. The presence of the ciliary body at 8-9 mm

from the limbus must always be kept in mind and excessive cauterization in this area avoided. Muscles can usually be pulled aside, though if this does not give sufficient access they should be detached and re-inserted at the end of the operation. Separate holes in different regions of the globe can, of course, be treated at the same operation. In cases where no hole is visible a band of cauterization, some 2 mm. wide, at a distance of about 11 mm. from the limbus, may be applied in each quadrant of the globe where detachment exists; this is done on the assumption that a hole is present but is too far forward to be seen with the ophthalmoscope; however, the prognosis in these cases seems very poor. Finally the sub-retinal fluid is evacuated in the region where the detachment is deepest; this may be done by allowing the electrode to stay in contact with the sclera at one spot or by trephining the sclera and then perforating the choroid with a blunt instrument. Larsson favours the latter as he thinks thereby drainage of the sub-retinal fluid may continue for some while but it hardly seems probable that a small perforation in the choroid will remain patent for long. Finally, any detached muscles are re-inserted and the conjunctiva stitched. If the fundus be now examined a diffuse, white area in the choroid is visible and a rough estimate can be made as to its relation to the hole. Both eyes are bandaged and the patient nursed in a position which allows the hole to be dependent, though we have not thought it necessary to raise the foot of the bed in cases where the hole is in the upper part of the fundus. Atropine is instilled daily from the first and a preliminary examination of the fundus made after 48 hours, provided the excursions of the eye are limited. In favourable cases the detachment will be much shallower, though a considerable amount often remains for a few days. If, after five or six days, gross detachment still persists, the operation is unsuccessful and the patient should be allowed up. In successful cases, any detachment which is present at first rapidly settles down, though considerable swelling of the coagulated choroid, over which, of course, the retina is raised, is usual and this is often quite obvious for two or three weeks. After two weeks the patient is allowed up with both eyes uncovered; glasses in which only a small central aperture is present, designed to ensure movements of the head rather than of the eyes, can be prescribed, but it seems that, after a fortnight, favourable cases may be allowed reasonable activities with safety.

Of the 31 cases 18 were cured, *i.e.*, 58·06 per cent. Eleven of these left hospital with no detachment whatever visible; in seven there was seen, around the cauterized area, a certain amount of residual detachment due, no doubt, to local swelling of, and possibly exudate from, the choroid. In no case has an increase

of this local detachment been noted at subsequent examinations, so I have thought it fair to include them as cures. In most cured cases the field to a one degree object at one-third of a metre was full, or showed only a small loss corresponding to the operation site, and it was often very remarkable how little field defect was produced by extensive choroidal scarring, though no doubt this would have been more obvious if a small object on the screen had been used. The improvement in central vision was variable; if the macula had been detached, from counting fingers vision of 6/60 or 3/36 was usually obtained, while in those cases where the macula was still attached, an increase of one or two lines on Snellen's type was general.

One cured case is of sufficient interest to merit special mention. He was first admitted with an intra-ocular foreign body which could be seen lying in the retina down and out. The lens was not injured and the vision was 6/18. The foreign body was successfully removed by the anterior route and his convalescence was uneventful. He continued to attend the out-patient department regularly and after six weeks complained that the vision of the eye was failing; examination showed an extensive detachment below with corresponding field defect and a small hole at the original site of the foreign body. The macula was not involved and the vision 6/36. Diathermy was applied to the lower and outer segment of the eye; the retina went back completely, and he was discharged with a full field and 6/24 vision.

In the series no sort of selection was made. The average age of the patient and duration of symptoms were 43 years and 33 weeks respectively in cases where the operation failed, and 41 years and 6 weeks respectively in those cases cured. Further, in seven of the cases one or more previous operations, either Gonin's or Guist's, had been done, and in only one of these was the result successful. In 6 of the 31 cases no hole was found and, again, in only one was the result satisfactory. Obviously if the more unfavourable cases be rejected the figure of 58·06 per cent. of cures can be improved.

Larsson in 40 unselected cases had 50 per cent. of cures, and in 33 selected cases 60 per cent. of cures. Complications were notably absent following the operation. A fair degree of local external reaction was usual but soon settled down. In no case was there any marked increase of vitreous opacities attributable to the operation, nor was there any large vitreous haemorrhage, though sub-retinal and intra-choroidal extravasations of blood were seen. Thrombosis of a vortex vein did not occur. I understand that in Vienna embolism of a choroidal artery leading to an area of choroidal atrophy, which may spread to the macular area, has been observed following diathermy, but we did not experience this.

Conclusions

Whilst this series of cases is too small to allow of any final opinion I think it may fairly justify the following conclusions:

1. That in diathermy we have a method of cauterization for the treatment of retinal detachment preferable to the thermocautery used by Gonin or the solid caustic potash used by Guist. Further, the technical difficulties are considerably less than in the latter operation.

2. Cases where no hole can be found and those in which a previous operation for detachment, of any type, has been done, offer small hope of success.

3. The age of the patient is of small importance but the prognosis is much less favourable when the symptoms of detachment are of long standing.

4. Finally, as might be expected, almost all cases showing *inflammatory signs, post-cortical lens changes, gross vitreous* opacities, and hypotension do badly, while those with a relatively *clear vitreous, discrete hole or holes, and a normal tension*, are the most favourable.

A new diathermy apparatus has now been installed at Moorfields to replace that used in this series of cases. This machine, which was supplied by Messrs. John Weiss & Co., has been specially made for this operation. It generates a diathermy current of low frequency and has a milliampèremeter which gives rapid readings up to 100 milliampères. I have had no practical experience with it but I understand that, using a current of approximately 60 milliampères, results have been very encouraging.

I would like to express to the Honorary Staff of Moorfields Eye Hospital my gratitude for their permission to publish these cases.

THE HISTOLOGICAL APPEARANCES OF AN EYE SUCCESSFULLY TREATED BY DIATHERMY FOR RETINAL DETACHMENT. FATAL TERMINATION FROM PULMONARY THROMBOSIS ON THE NINETEENTH DAY AFTER OPERATION

BY

H. B. STALLARD

LONDON

THE opportunities for histological examination of human eyes subjected to the surgical treatment of retinal detachment are rare. Gonin's cauterization of retinal tears has been succeeded by Guist's multiple trephines and caustic applications and now Larsson's

diathermy is under trial. This brief report concerns a patient treated in the last manner. The eye was obtained at post-mortem 19 days after operation.

Clinical Notes

J. H., aged 74 years, was admitted to St. Thomas's Hospital under the care of Mr. P. G. Doyne, on September 9, 1932, with defective right vision of a few days' duration. A large retinal detachment was present in the upper temporal quadrant with a tear in the 10 o'clock meridian between the equator and ora serrata. The retina of the left eye had been detached some years before.

On September 21, 1932, Mr. Doyne operated under local anaesthesia using a modified Larsson's technique. Diathermy applications were made to the sclera in the upper temporal quadrant of the globe between the equator and ora serrata and finally a puncture was made with the electro-cautery at the assumed site of the retinal tear.

During the fortnight after operation the retina became completely re-apposed and a few scattered white spots were seen at the site of the former detachment. On the 13th night after operation the patient had a small pulmonary infarct at the right base and

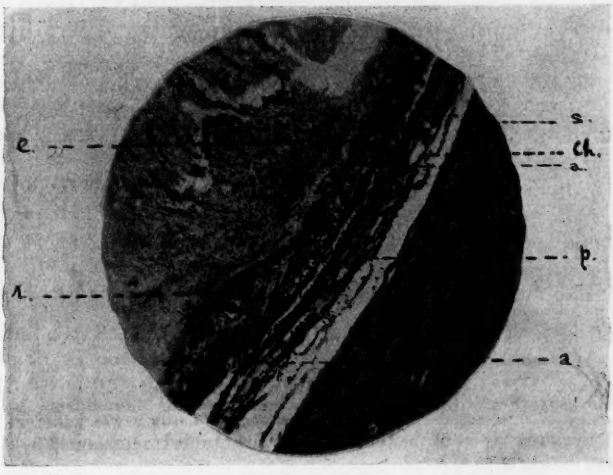

FIG. 1.

s. Sclera. Ch. Choroid. r. Retina. a.a. Adhesions between choroid and retina. *p* Plasma cells and lymphocytes in the choroid. *e* Exudate, fibrin and polymorphonuclear leucocytes in the vitreous.

on the 19th day he died, 20 minutes after an extensive pulmonary thrombosis.

At post-mortem the whole pulmonary vascular system and also the iliac and femoral vessels were filled with ante-mortem clot. The right eye was removed through the roof of the orbit, fixed in Zenker's solution and serial sections cut through the site treated by diathermy.

Pathological Report

The sclera, at the points touched by the diathermy, shows a zone of hyaline degeneration staining a sherry-brown colour with haematoxylin and eosin for about one-eighth mm. in depth. Nowhere was there any considerable tissue loss, serious damage or necrosis.

The choroid beneath the site treated by diathermy presents aggregations of lymphocytes, plasma cells and a few giant cells.

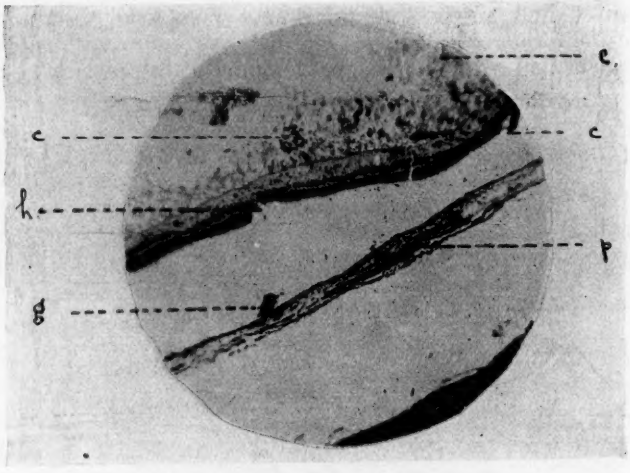

FIG. 2.

The separation of the retina from the choroid and the choroid from the sclera is an artefact. The bud of granulation tissue *g* was adherent to the outer layers of the retina and the site of this is represented by a gap in the retina at *h*.

e. Granular exudate in the vitreous. *c.c*. Clumps of large mononuclear cells, polymorphs and lymphocytes. *g*. Bud of granulation tissue herniating through Bruch's membrane and the retinal pigment epithelium. *p*. Infiltration of the choroid by plasma cells and lymphocytes. *h*. Gap in the outer layers of the retina where a bud of granulation tissue from the choroid was adherent.

Small clumps of inflammatory cells have burst through Bruch's membrane and the retinal pigment epithelial layer, and these assist in forming adhesions between the choroid and retina, at which points fibroblasts are in evidence (see Figs. 1 and 2).

The inflammatory response has extended forwards into the ciliary body and iris, and the non-pigmented layer of ciliary epithelium has proliferated excessively.

Fibroblasts are present in the circum-lental space.

The retina shows degeneration of the rod and cone layer throughout the detached area, and fibroblasts and plasma cells infiltrate its disorganized structure.

Clumps of large mononuclear leucocytes, polymorphs and lymphocytes are present on the hyaloid membrane and in the adjacent vitreous (see Fig. 2).

The vitreous is drawn forward and is adherent to the retina and pars plana of the ciliary body at and near the site of the diathermy application. Exudate, polymorphonuclear leucocytes and strands of fibrin are present in it.

Conclusion

The histological picture induced by the application of diathermy to the sclera in the treatment of retinal detachment is that of a localized uveitis. Buds of granulation tissue herniating through Bruch's membrane play an important part as the grappling irons that secure the detached retina when it has come alongside the choroid after the sub-retinal fluid has been drained. These buds of granulation tissue contain fibroblasts, the precursors of fibrous tissue. Repair is eventually perfected by choroido-retinal fibrous tissue adhesions.

It is evident from this specimen that diathermy applied near the ora serrata is liable to induce a cyclitis, and the amount of fibrous tissue formed in the circum-lental space prophesies more remote complications to follow.

I thank Mr. P. G. Doyne for sending me the specimen and for permission to publish this case, and his house surgeon, Mr. H. Ridley, for supplying me with the clinical notes.

MYDRIATIC SYNERGY

A note on the use of mydriatics by sub-conjunctival injection

BY

FRANK FLYNN

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THE usual method of producing mydriasis by the instillation into the conjunctival sac of atropine sulphate in the form of drops does not cause maximal dilatation of the pupil even in normal eyes; and it is well known that in cases of iritis, when the iris is congested and becoming bound to the anterior lens capsule by plastic synechiae, atropine drops often produce only a very slight effect.

This has led to a search for a more powerful mydriatic. Laevoglaucosan (Laevo-rotatory deltanephrin two per cent. and methylaminoacetopyrocatechal two per cent.) is certainly a very potent one. It is used in the form of drops—two drops being instilled at intervals of 15 minutes until five applications have been given. Besides requiring an hour for its administration it is often accompanied by much pain which the previous use of cocaine may or may not relieve, and further it is a very expensive drug. Its routine use, therefore, is hardly practicable.

But why does atropine fail? It is, I think, because the rate of absorption when given in the usual manner is slow, and the actual concentration in the aqueous at any particular time during treatment is very low. Moreover, this line of action aims merely at paralysing the sphincter muscle so that any dilatation that occurs depends on the normal tone of the dilator muscle and the elasticity of a congested oedematous iris, which factors necessarily are not great.

The solution used here is essentially a synergic mixture of atropine, cocaine and suprarenin, given sub-conjunctivally. Sub-conjunctival injection has the obvious advantage of causing the drugs to enter the aqueous in a very much higher concentration than occurs when they are placed in the conjunctival sac. At the same time it increases greatly the rapidity with which their effects are produced.

As regards the action of the drugs, atropine, by its inhibitory effect on parasympathetic nerves, paralyses the sphincter muscle. Suprarenin, by its action on the sympathetic, stimulates the dilator muscle, and by vasoconstriction of the conjunctival and ciliary vessels prevents the solution passing rapidly into the general

blood stream, thus tending to localize the effects of the drugs to the site of injection. Further, it lessens the vascular engorgement of the iris and so diminishes its volume. Cocaine aids the suprarenin in the production of the above three actions through the sympathetic, besides rendering the injection and the resulting mydriasis painless.

At first small doses were used; (atropine 1/120 gr., cocaine 1/30 gr., suprarenin 1/1,500 gr.) later these quantities were gradually increased and untoward effects carefully watched for—fortunately none was noted—until the dosage that is now recommended was reached.

Preparation of the Solution

The solution, which for convenience has been termed mydricain, contains, in each five minim dose, atropine sulphate gr. 1/60, cocaine hydrochloride gr. 1/10 and laevo-rotatory suprarenin gr. 1/600, in the form of the hydrochloride, together with sodium chloride gr. 1/80 and chlorbutol gr. 1/120, in sterilized water.

The method of preparation is that usually employed for hypodermic injections. Atropine sulphate, cocaine hydrochloride, and sodium chloride are dissolved in sterile water and the solution sterilized for 30 minutes at a temperature of 115° C. to 116° C. Chlorbutol is then dissolved in this solution; finally, when it is cool, the suprarenin hydrochloride is added. Six minims of this solution are introduced into brown ampoules, which have previously been sterilized in an autoclave at a temperature of 150° C. for one hour. The ampoules should conform to the test for alkalinity of glass. By this method of preparation the danger of decomposition, owing to oxidation, is eliminated; the solution is sterile and its activity persists.

Therapeutic Value

The indications for the use of mydricain are similar to those for laevo-glaucosan, that is, when a powerful mydriatic is desired. It is not, however, suggested that the iris of a patient with acute iritis should be subjected repeatedly to the rather drastic stimulation of this preparation. The essential object which should be aimed at in the treatment of such a case is, of course, prolonged rest for the iris, and this can be achieved by means of atropine alone. But in the initial stages of an attack, when posterior synechiae are in process of formation, in my opinion an energetic attempt should be made to get the pupil well dilated and the iris free from the anterior lens capsule before being content with a

less vigorous mode of treatment. The injection may, however, have to be repeated if a sufficient effect is not obtained the first time—this may be the case when treatment is not begun until late in the course of the disease. If another injection is considered necessary it should not be administered until the following day, so that not more than five minims are given in each 24 hours.

This method is also convenient for producing rapid maximal mydriasis preparatory to the extraction of an intra-ocular foreign body. The injection is best given immediately before the operation, when the patient is already on the table. The same remarks apply to cases with a perforating corneal wound with prolapse of iris tissue.

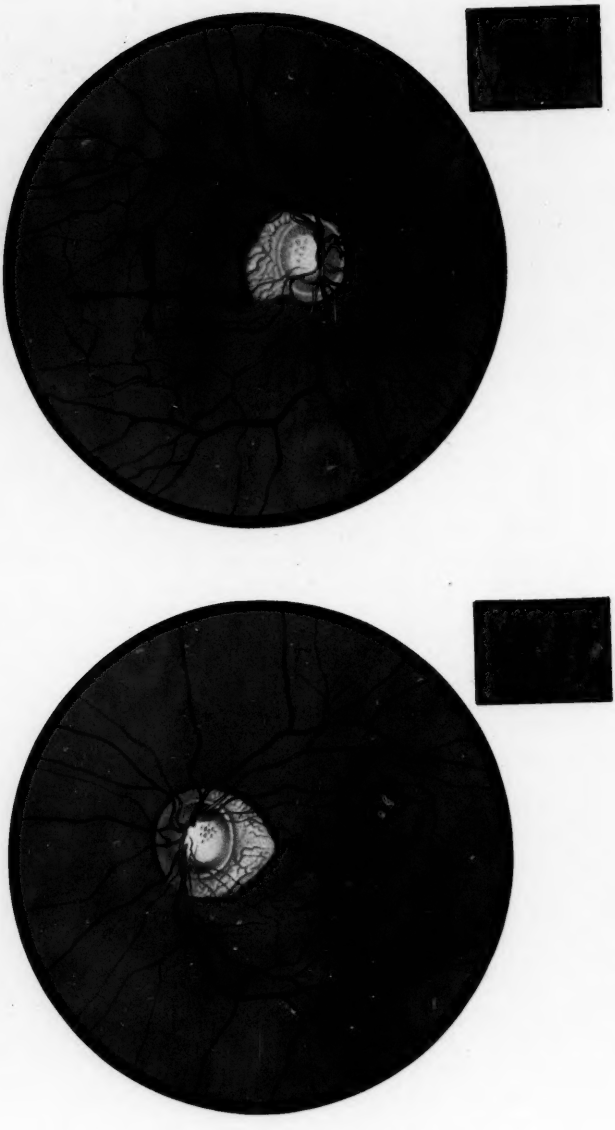
Other types of cases where this treatment is helpful will suggest themselves; for example, a child with congenital cataract appearing for the second or third needling, whose pupils have not responded to the prolonged use of atropine drops. If such a patient is to have a general anaesthetic the usual pre-operative hypodermic injection of atropine must be omitted.

It is important also that the limitations of this method be recognized; obviously it will be ineffective in separating long-standing organized synechiae. It seems, from experience so far gained, that a result can be expected if the synechiae have not existed for longer than a month. In one case, where a small synechia had definitely been present for three weeks, dilatation was finally produced and the pupil became regular in outline, but only after injections had been made at a point corresponding to the position of the synechia, for three successive days. It is essential, therefore, to apply the treatment early if success in this respect is to be assured.

Other beneficial results, beyond the mere breaking down of synechiae, are often produced. Thus cases of iritis with plastic exudate in the anterior chamber and corneal ulcers with generalized haze of the corneal stroma show a more rapid improvement than with the usual method of treatment. The cornea becomes brighter more rapidly, and absorption of the exudate and clearing of the anterior chamber are aided considerably. These, which may be termed remote effects, must surely be secondary to the changes produced in the iris, at any rate, no other explanation is offered here.

Again, in cases of recurrent iritis with numerous old synechiae, it is sometimes impossible to decide by the usual clinical methods how much of the pupil is permanently bound down, and the onset if iris bombé may be feared. An injection of mydricain will show exactly how far the process of pupillary seclusion has advanced.

Another interesting point is that patients who have had atropine



Right and left fundus oculi. Insets from periphery of fundi.

irritation tolerate this treatment quite well and without a repetition of the dermatitis. In one such case where there was some doubt as to whether the patient had really been irritable to atropine this fact was subsequently proved by the instillation of drops.

Technique

A few drops of cocaine (four per cent.) are instilled beforehand, first, to eliminate the possibility of a cocaine idiosyncrasy, and secondly, to prevent the patient feeling the initial prick of the hypodermic needle—the subsequent action is, in any case, quite painless. I have observed a synechia in process of breaking down while examining a patient with the slit-lamp immediately after an injection, and on repeated questioning he would not admit that he felt pain. Atropine drops or ointment usually are instilled after the injection with the object of providing a steady absorption of this drug.

As regards the site of injection, it is a good plan to decide what will be the most resistant part of the pupil, for example, where there is an obvious synechia. The injection should then be made subconjunctivally, raising a bleb, a few millimetres from the limbus at a point corresponding to this part, because the first and maximum effect will be produced here and become proportionately less marked at points on the corneal circumference more remote. On the other hand, if the iris is a comparatively normal one and general maximum dilatation is required, it is not a difficult matter, by gentle pressure with a swab over the site of injection, to make the fluid spread around at least three-quarters of the globe. Should a sub-conjunctival haemorrhage occur it is of no consequence.

A word about the rapidity of action should be added as this is rather startling when seen for the first time. Accurate records of the time factors have been made. It will be sufficient to say that the pupil first begins to dilate 30 to 60 seconds after the completion of the injection and the effect is at its maximum in three to four minutes, though further dilatation may occur for some hours.

I am indebted to the honorary staff of Moorfields for the opportunity of treating, by this method, patients under their care. I would also like to thank Sister Hartshorne for her much appreciated assistance, and Mr. Clarke, hospital pharmacist, for the preparation of the various solutions and for his helpful suggestions.

ABSTRACTS

I.—RETINA

(1) **Hudson, A. C.—London.—Retinal pigmentation, probably congenital.** *Proc. Roy. Soc. Med.*, November, 1932.

(1) The abnormality, which is illustrated in the coloured plates facing p. 302, was present in both eyes of an apparently perfectly healthy male, aged 28 years, and was not associated with night blindness or defects in the visual fields. Central vision with each eye was 6/6, after correction of a low degree of myopic astigmatism.

The pigmentation appeared to be situated behind the retina proper, at the level of the retinal pigment epithelium.

A. C. HUDSON.

(2) **Larsson, Sven (Stockholm).—Operative treatment of retinal detachment by electro-endothermy and trephine. (Operative Behandlung von Netzhautabhebung mit Elektroendothermie und Trepanation).** *Acta Ophthal.*, Vol. VIII, p. 173, 1930.

(2) **Larsson** in this paper describes his technique for treating retinal detachment by means of electro-endothermy. A large indifferent electrode is placed on the leg and thigh, a gauze pad soaked in saline is interposed between the skin and the electrode and secured by a gauze bandage. The active electrode is a metal ball, 0·66 mms. in diameter, and the current used 1—1·05 ampères as registered by the ammeter when the electrodes are in contact.

The site of the retinal detachment is exposed by dissecting up a conjunctival flap. The active electrode is applied to the sclera for 5 seconds at points a few millimetres apart. The sclera at the points of contact becomes opaque and sometimes dark. The sclera is then trephined at a point corresponding with the most dependant portion of the retinal detachment.

The patient is confined to bed, with the head placed in such a position that the detached area of retina lies inferiorly, and kept so for 2 weeks with both eyes bandaged. In a successful case re-attachment is evident in 5-8 days.

The apparatus recommended is a Siemen's Thermoflux K.

H. B. STALLARD.

(3) **Larsson, Sven (Stockholm).—Results of electro-endothermy in detachment of the retina.** *Acta Ophthal.*, Vol. X, Fasc. 1-2, p. 173, 1932.

(3) **Larsson** surveys the surgical method introduced by Gonin for detachment of the retina. He agrees that closure of the rupture or hole in the retina is of the utmost importance, but believes that

this interruption in the retina is probably secondary. The author does not perform Gonin's operation for the following reasons:—

(i) He cannot unreservedly accept the theoretical basis of the operation.

(ii) It is undeniably exceedingly difficult to locate the rupture, not to say impossible.

(iii) The object of the author's endeavours is to obtain extensive fixation of the retina to underlying tissue, and possibly choroidal atrophy, thus reducing the accumulation of sub-retinal fluid as much as possible.

A table is given of the comparative results of Gonin and other operators.

Larsson employs trans-scleral electro-endothermic current, and performs subsequent trephining of the sclera. He has operated on 30 cases, both good and bad cases as regards the duration of the detachment, and has achieved 40 per cent. (possibly 43 per cent.) successes with complete re-attachment of the retina.

H. B. STALLARD.

(4) **Sourdille (Nantes).—The treatment of retinal detachment. (Tratamento del desprendimiento retiniano).** *Arch. de Oftal. Hisp.-Amer.*, Vol. XXXIII, May, 1932.

(4) In this paper **Sourdille** describes his method of treating detachment of the retina by multiple scleral puncture. He contests Gonin's acceptance of Leber's theory of the genesis of detachments from tears associated with abnormality of the vitreous, and considers that one must look for the cause in a lesion of the apparatus of union of the two retinal layers. The principle of treatment is to let out the sub-retinal fluid and to provoke an adhesive choroido-retinitis, but Sourdille differs diametrically from Gonin in that he considers it essential to puncture the retina during the operation, and thinks that sub-retinal fluid can pass to be absorbed by the vitreous through such a puncture.

The technique of the operation is briefly as follows:—

After a rest of two days in bed, during which a careful plan of the retina is made and during which 2 grm. calcium chloride a day are administered to minimise the risk of haemorrhage, the eye is anaesthetised and the conjunctival sac washed out with 1 in 10,000 mercuric oxycyanide. A retraction stitch is inserted at the limbus. The conjunctiva is picked up in rat-toothed forceps and a special von Graefe knife, 2 to 3 mm. wide, thrust obliquely through conjunctiva and sclera to a depth of 10-12 mm., usually at a distance of 14-17 mm. from the limbus. A large number of punctures is made near the retinal tear. A solution of cyanide of

mercury is then given as a sub-conjunctival injection, and atropine and morphine ointment inserted into the conjunctival sac. The head is kept still for eight days and the patient allowed up on the 15th day. There is often much pain after the operation, and vitreous and sub-retinal haemorrhages may complicate it. About half the immediately cured cases relapse. The results (71 cures out of 169 cases, 40 of whom were operated on more than once) approximate fairly closely to those obtained by Gonin's method. Sourdille also considers prophylactic mercurial treatment of peripheral choroiditis in the other eye to be of value.

IDA C. MANN.

(5) **Mayes, Leo L. (Chicago).—The vitreous in experimental detachment of the retina.** *Arch. of Ophthal.*, June, 1932.

(5) **Mayes's** paper is in the nature of a preliminary communication concerning work which may have an important bearing on the pathology of retinal detachment. In the first place, the author refers to a previous paper (*Arch. of Ophthal.*, Vol. VII, p. 499, April, 1932) concerning a mechanical method of artificially detaching the retina. The result of using this method was that although a hole was produced in the retina, spontaneous re-attachment occurred after 6 weeks. The author therefore felt that some other factor must also be at work, possibly in the vitreous itself, so he tried the effect of injecting 3 minims of a 1 in 4 dilution of saturated trypsin solution in normal saline. The result was to bring about a prolonged detachment of the retina which nevertheless was not permanent. Investigation of the vitreous in eyes thus treated showed an enormous increase in sugar content, an increase in total nitrogen and an increase in surface tension, while there was a decrease in amino-nitrogen and in hydrogen ion concentration toward the acid side.

F. A. W-N.

(6) **Terry, T. L.—(Boston).—Histologic changes in an eye eight years after sclerocautery puncture for separation of the retina.** *Arch. of Ophthal.*, August, 1932.

(6) **Terry's** case was one of traumatic detachment of the retina in which three cautery punctures had been done at intervals of a few days without producing permanent re-attachment of the retina. Eight years later, the eye was excised for glaucoma. The sections showed that the retina was completely detached except at the disc, ora serrata, and the sites of the cautery punctures. In the latter positions, the retina had become reduced to a thin layer of neuroglia, fused with a mass of scar tissue which had replaced the choroid and sclera. In only one puncture had vitreous presented at the time of

operation, and sections through this, showed partly hyaline scar tissue projecting inwards into the vitreous, a condition which was absent in the other two cauterised areas.

F. A. W-N.

(7) **Friedenwald, Jonas S. and Chan, Eugene (Baltimore).—Pathogenesis of retinitis pigmentosa.** *Arch. of Ophthal.*, August, 1932.

(7) The aim of this investigation by **Friedenwald** and **Chan** was to discover what aspects of the local lesion might be considered primary and what aspects secondary. Pathologically there is a disturbance of the retinal pigment epithelium with a scattering of its granules in the retina, and in association with this are atrophy and destruction of the neural elements with glial proliferation and reduction in calibre of the vessels. The sequence of signs and symptoms:—night blindness, then obvious pigmentary disturbances and finally optic atrophy—suggests that the disease is primarily due to the pigmentary disturbance. In order to test this hypothesis, the authors made a suspension of melanin granules from pig's or cow's eyes, and injected 0.2 c.c. of it into the vitreous of one eye of each of 12 albino rabbits, the other eye receiving a control injection of 0.5 per cent. cresol in normal saline (the medium used for suspension of the melanin granules). The transport of pigment by phagocytic cells from the vitreous was exceedingly slow, but within one or two months, deposits of pigment could be seen in the lower peripheral retina, and sometimes near the disc. In the latter case, they assumed the familiar "bone corpuscle" pattern. Histologically there were numerous phagocytes loaded with pigment, and in the early cases many of Müller's fibres were found, packed with granules. Later, these fibres underwent proliferation, and there was considerable destruction of retinal tissue, particularly in those portions which were covered by a deposit of pigment. This is ascribed by the authors to the passage of phagocytes; "a structure so highly organised as the retina may, therefore, be supposed to suffer disorganisation when an army of heavily laden phagocytes tramp through." The occurrence of retinitis pigmentosa sine pigmento, would at first sight appear to be an obvious argument against this theory, but "sine pigmento" is probably only a relative term, and it is more than likely that if these cases were examined histologically, small clumps of pigment would be found which were invisible with the ophthalmoscope. In spite of this, however, the authors say that their experiments are not conclusive in deciding whether, in the natural disease, both elements in the neuro-epithelium are primarily involved, or whether the disintegration in the rods and cones is secondary to the scattering of pigment from the pigment epithelium or *vice versa*.

F. A. W-N.

(8) **Evans, John N. (Brooklyn).—Retinal perivascular delineation.** *Arch. of Ophthal.*, December, 1931.

(8) **Evans**, after a short historical survey, describes the experiments he has made to try and delineate the retinal perivascular spaces. Living eyes were used, and whenever possible, in adult albino rabbits. In the first series of experiments, a suspension of minute particles was injected into the vitreous at varying depths. Precautions were taken to ensure uniformity in size of the particles and the substances used were Indian ink, carmine granules and a suspension of ocular pigment. Forty-eight hours after injection, the mass in the vitreous developed definite radiating streamers, and at the end of two weeks or so, the pigment masses were seen lying against the retina, mainly below. During the ensuing weeks, the pigment masses seemed to cluster more and more over the nerve head. Microscopically, the particles were found to have been taken up by the histiocytes (large mononuclear tissue cells) without any relation to supposed or actual lymphatic spaces. The greater number of those cells present in the retina were in the nerve fibre layer, but the most conspicuous feature of the whole picture was the number of pigment bearing cells in the optic nerve, where again there was no definite relation to any particular tissue or channels. These experiments were therefore a failure from the point of view of delineating perivascular channels, so dyes were used instead, the best being an isotonic solution of Prussian blue. When this was injected into the vitreous, blue could be found later about the bipolar cells and their processes, and about the vessels of the retina and optic nerve. In the author's opinion the presence of the particles in these positions does not warrant the assumption that they lie in a formed space.

F. A. W-N.

(9) **Adler, Francis Heed (Philadelphia). The metabolism of the retina.** *Arch. of Ophthal.*, December, 1931.

(9) **Adler** has noted in a previous communication (***Trans. Amer. Ophthal. Soc.***, Vol. XXVIII, p. 307, 1930) that the sugar content of the normal vitreous was always considerably lower than that of the aqueous or blood serum of the same animal, although the sugar content of the vitreous rose when that of the blood was increased. A study of glycolytic activity showed that the retina could split sugar almost twice as quickly as any of the other ocular tissues, a fact which would account for the low sugar content of the vitreous. Further proofs of this are adduced in the present paper. In the first place the concentration of sugar in the posterior layers of the vitreous is considerably less than in the anterior layers, and secondly, when the retina has been put out of action by section of the optic

nerve three months previously, the sugar content of the aqueous rises above the normal, and that of the vitreous, very much above the normal. Experiments to measure the glycolytic activities of the retina showed the same thing, the atrophic ones using much less sugar per hour than did the normal retinae.

F. A. W-N.

II.—MISCELLANEOUS

(1) **Greig, David M. (Edinburgh).—Recurrent bleeding from the eyes.** *Edin. Med. Jl.*, October, 1932.

(1) An admirable critical review of the literature on this subject is contributed to the *Edinburgh Medical Journal* of October, 1932, by **David M. Greig**, conservator of the museum of the Royal College of Surgeons, Edinburgh. The old name of bloody tears is obviously an error, for, as Dr. Greig points out, there is no bleeding from the lacrymal glands, and the blood comes from the conjunctiva or caruncle. The condition, while not unknown in the male sex, is much more common in the female, and in olden times was thought to have some connexion with abnormal menstruation. Hippocrates noted that in such a condition an epistaxis could occur. The earliest reference in English literature is that of Clopton Havers in the *Philosophical Transactions* in 1695. The patient died of a "sluce of blood." Mackenzie, in 1854, seems to have voiced the doubt as to the bleeding coming from the lacrymal gland, and suggested the conjunctiva as a source. Dr. Greig's article ends as follows: "It seems not unnatural that in relation to psychic stimulations, puberal re-adjustments and menstrual irregularities should be thought to indicate the apparent cause, but it is less apparent from the case quoted above, that they are far less obviously the exciting agents than is the so-called hysterical state. . . . It is a central psychic excitation, not a peripheral mechanical one.

It is significant that so many of the women who exhibited the phenomenon of recurrent ocular discharge of blood were potential epileptics, and though only the ocular disturbance is reviewed in this paper, it is recognised to be only a local manifestation of a vasomotor lesion, the counterpart of local recurrent haemorrhages elsewhere. . . .

Perhaps the delicacy of the subconjunctival circulation, its amenability to vasomotor disturbances, and the vascularity about the caruncle, may predispose that area to recurrent bleedings. . . ."

R. R. J.

(2) **Clay, Grady (Atlanta).—Angioid streaks of the retina and pseudo-xanthoma elasticum.** *Arch. of Ophthal.*, September, 1932.

(2) **Clay's** paper opens with a short description of the fundus changes found in this condition and describes it as being "apparently acute," "and characterised by the formation of haemorrhages exudates and striae." The streaks are usually associated with the presence of central choroiditis and in many cases with a skin condition called pseudo-xanthoma elasticum. This occurs usually in early life and consists in the development of yellowish punctate or linear discolourations in the skin of the neck, axillary folds, cubital fossae, popliteal spaces, and sometimes the abdomen and chest. Histologically, there is an increase in the amount of elastic tissue accompanied by degenerative changes in it. Of the seven cases of angioid streaks reported by the author, five showed pseudo-xanthoma elasticum of the skin, one senile elastosis, and three, an evident vascular anomaly. The author is of opinion that the association of these diseases is not a chance one, and he postulates a similar change in the sclera (*i.e.*, an increase in its fibro-elastic tissue). Short posterior ciliary veins are sometimes present, and if so, they become thrombosed by the pressure of the elastic tissue, resulting in the presence of haemorrhages, exudates and streaks, corresponding to the vessels involved. Angioid streaks, according to this theory are therefore in the choroid and not in the retina.

F. A. W -N.

(3) **Eager, Richard and Fisher, John W. (Exeter).—A case of pseudo-mirror writing and some observations.** *Lancet*, April 23, 1932.

(3) The extremely interesting case here recorded by **Eager** and **Fisher** is hardly suitable for abstract in an ophthalmological journal. In detail it deals with cerebration, not with vision. Without attempting to abstract the article, one may show, in the author's words, the distinction to be drawn between mirror-writing and pseudo-mirror writing. "The writing (in this case) is not true mirror-writing; it is backward writing, with the letters correctly orientated, and written with the right hand in dextrad fashion, from left to right of the paper. This pseudo-mirror writing . . . is unintelligible when reflected in a mirror, save for an isolated word here and there. Secondly, it is associated with upside down reading and drawing, and backward spelling. . . . "

For the details of the case one must refer to the original with its reproduction of the remarkable caligraphy and drawing, to say nothing of the astonishing arithmetical efforts of this patient.

ERNEST THOMSON.

BOOK NOTICES

Clinical Ophthalmology for House Surgeons and Students. By J. Myles Bickerton, M.A., B.Ch.(Cantab.), F.R.C.S., and L. H. Savin, M.D., M.R.C.P., F.R.C.S. Pp. 147. 92 illustrations (including 6 plates). H. K. Lewis and Co., Ltd. 1933. Price, 7/6 net.

The authors have intended this book for house surgeons and students. It contains chapters on methods of examination, diseases of the lids and orbit, "forms" of conjunctivitis, "some affections" of the iris, ciliary body and sclera, corneal diseases, diseases of the lacrymal apparatus, cataract, glaucoma, sight-testing for beginners, squint, ocular injuries and ophthalmoscopic appearances in disease. A chapter is devoted to prescriptions and therapeutic agents, and there is an illustrated appendix of instruments required for certain ophthalmic operations.

There are several omissions in pathological descriptions, but these are mostly outside the scope of such a work. In the account of operations a 2 mm. trephine is advised as a routine for chronic glaucoma and no mention is made of the 1·5 mm. trephine which is used by the majority of surgeons. Also a button-hole iridectomy is recommended before extraction of the lens is made in cataract operations. Such phrases as the Graefe knife is "stuck" into the eye, a discission needle is "pulled out" of the anterior chamber, and the lens capsule is "scratched," ill express the precise and delicate handicraft of ophthalmic surgery.

From a house surgeon's point of view, this book is disappointing, except for a few words about bandaging cataract cases and post-operative delirium, there is no account of the post-operative treatment of cases, the complications that may arise, and the methods of dealing with these. Even the description of casualty work in removing foreign bodies and the methods of treating ocular injuries is scanty and inadequate.

Practical Textbook of Ophthalmology. Manual práctico de oftalmologia. By Raul Arganaraz. Pp. 704. Buenos Aires. El Ateneo. 1932.

This, the second edition of Professor Argañaraz's excellent textbook, has been brought thoroughly up to date by the inclusion of the salient features of all the recent work on such subjects as biomicroscopy and detachment of the retina. The book is primarily intended for students, undergraduate or post-graduate, and its author states that it is in reality a full transcription of the course of instruction at his hospital. He strongly condemns the practice

of note-taking by students at lectures and demonstrations, first, on account of the distraction of the mind from the actual observation of the case, and secondly, because no one can possibly take down everything. He has, therefore, tried to provide in book-form all the information which he seeks to impart at his lectures, and the result is eminently successsful. Throughout the book stress is laid both on the necessity for a knowledge of the anatomy, physiology and pathology of the eye, and on the even greater importance of realizing the connection between ocular and general disease. He emphasizes the necessity of a complete and thorough examination, both of the eye itself and of the symptomatology of the patient.

The book begins, characteristically, with his Inaugural Lecture at his appointment in 1925. It is thereafter divided into 23 chapters, dealing exhaustively with diseases of the eye and adnexa, and with the diagnosis of nervous and other general diseases presenting ocular signs. There are numerous clear and well-reproduced illustrations, 589 in all, a large number in colours. The book is written in an extremely clear and simple style, and although from the amount of information it contains it must of necessity be condensed, the number of illustrations makes it possible for the student with no previous knowledge of ophthalmology to follow it easily. It is altogether a most excellent production, and Professor Argañaraz is to be heartily congratulated.

Medical and Surgical Diathermy in Ophthalmology. La Diathermia médica y quirúrgica en oftalmologia. By DR. GUNTHER VON GROLMAN. Pp. 162. Buenos Aires. Frascoli y Bindi. July, 1932.

This monograph of Dr. von Grolman issued from the clinic of Professor Raul Argañaraz deals exhaustively with the clinical uses of the diathermic current in ophthalmology up to the beginning of 1932. It is perhaps unfortunate that the latest and most hopeful development of this therapeutic measure, namely, its application to the cure of detachment of the retina, has occurred too recently for its inclusion in the work. Apart from this inevitable ommision however, the monograph supplies a most exhaustive and useful account of the employment of high-frequency currents. After a short chapter on the history of the diathermic current, the author gives a full account of its nature, of its various forms and of the principal types of apparatus used to produce it. The electrodynamics of the current are gone into and there are numerous excellent and simple diagrams of possible circuits in the different forms of apparatus. The question of special electrodes for use in eye work is then dealt with, after which the physical and biological effects of the current are indicated. The next section considers the

indications for its use. These are of two classes, depending on the type of current one is dealing with. In the first instance, all inflammatory conditions demanding the application of heat to the part can be so treated since the diathermy current generates heat in the tissues themselves to a far greater and more accurately controllable extent than do external applications such as the fomentation or the electric pad. Secondly, the coagulating and cutting currents (diathermy knife) can be used to produce haemostasis and to remove neoplasms when dealing with the adnexa. The last section contains case histories and photographs of 89 of the author's own patients, and includes such conditions as epithelioma of the lid, episcleritis, blepharitis, angioma, rodent ulcer, lymphatic cyst, xanthelasma palpebrarum, trachoma, phlyctenular conjunctivitis, iritis, interstitial keratitis and other corneal disorders. The cases were in part obviously experimental. The results are set out impartially and no exaggerated claim is made for the treatment, nevertheless, one gathers a definite impression that the method may be deserving a somewhat wider use than it enjoys at present.

The Prevention of Blindness and the Conservation of Sight as a Co-operative Movement. By PARK LEWIS, M.D., Vice-President of the National Society for the Prevention of Blindness. Publication 109. Price, 15 cents.

Park Lewis in this interesting paper has given an account of the preventive work done in connection with diseases of the eye and in particular, ophthalmia neonatorum. He alludes to the dictum of a distinguished Italian jurist, that if you would have a thought accepted it must be repeated five times; the first time it receives no attention; the second it is not heard; the third it is not understood; the fourth it is not believed; therefore it is necessary to say it a fifth time. In 1881, Credé published his discovery that an infection of the eyes which was causing one-quarter of the blindness in young children throughout the world, could be effectively prevented by a simple measure that any intelligent person could use. However, in spite of the interest taken in this matter, and the efforts of a small group of English people called the London Society for the Prevention of Blindness, Credé's preventive work in ophthalmia neonatorum was not practised at all widely for a quarter of a century. In 1908, certain procedures were advised (1) the registration of births; (2) the supervisory control and licensing of midwives by the boards of public health; (3) that a midwife must report any case of ophthalmia neonatorum in her practice; (4) free distribution of ampoules containing the prophylactic agent; (5) that records of ophthalmia neonatorum be kept.

Until these measures were adopted in America the incidence of blindness from ophthalmia neonatorum was around 26 per cent. of all children entering blind schools. In 1931, the figure had fallen to 7·5 per cent.

The necessity for International co-operation in the preventive work of blindness has been recognized and at the conclusion of the Ophthalmological Congress in Holland in 1929, an International Association for the Prevention of Blindness and an International League for the Control of Trachoma were formed.

OBITUARY

ARTHUR COOKE, of Cambridge

THE sudden death of Mr. Cooke on March 13 was noted in our last number.

The son of Mr. H. J. Cooke, of Bradford, Arthur Cooke was born in 1869. He was educated at Giggleswick, New College, Oxford and the London Hospital. At Oxford he obtained his blue for cross-country running. He qualified M.B., B.Ch., at Oxford in 1895, and on the advice of Sir Frederick Treves, joined a well-known firm of general practitioners in Cambridge. In 1898, he became M.A., Cantab. and took the F.R.C.S., Eng. Appointed assistant surgeon to Addenbrooke's Hospital about 30 years ago, he was, at the time of his death, senior surgeon and head of the Ophthalmic Department. He was always interested in ophthalmology, having been a student at Moorfields. He joined the Ophthalmological Society in 1901.

Cooke held the rank of Major, R.A.M.C.(T), before the war, and on the outbreak of hostilities he was attached to the First Eastern General Hospital. Most of his service was in France, attached to various military hospitals with the rank of Lieut.-Colonel.

At the end of the war he gave up general practice and confined himself to general surgery, as a consultant, and to ophthalmology.

He will be much missed at Cambridge and in the surrounding Counties. He was an ex-president of the Cambridge Medical Society. A lasting monument to an able surgeon and a very charming personality will be the new Eye Wards at Addenbrooke's, which are nearing completion, in the raising of funds for which he was indefatigable.

To his widow and surviving children the sympathy of the ophthalmic fraternity will go out in their bereavement.

CORRESPONDENCE

FILARIA LOA

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

SIRS,—The following case may prove of interest to your many readers, being one of extreme rarity in this country.

Mrs. M., aged 45 years, consulted me recently complaining of great discomfort in her right eye, which she was certain was due to a filaria, having had a similar attack previously. She had spent several months in Nigeria and the surrounding districts during the past four years, and stated she had been bitten by a fly on one of her earlier tours, since when she was conscious of two filaria in her system.

On one previous occasion an unsuccessful attempt had been made to remove the two worms in Aba when they appeared simultaneously beneath the skin of the upper lid.

The filaria is transmitted by the krysops fly, and according to native lore it is supposed to cross the eye about every four months, but in this case this is the first time the filaria has appeared under the conjunctiva.

Filaria evidently do not reproduce their species in the human body, probably requiring a new host to do so and are said to exist for seven years in the human body before dying out.

While usually occupying the deeper structures, heat brings them to the surface, and no doubt the spell of hot weather experienced last summer accounted for the superficial position of the filaria in this case.

Foster Moore records one case, and Parsons gives details of a filaria found in the anterior chamber.

It is understood that in most cases only mild discomfort is experienced, but in this case the pain was very acute, and is so whenever the filaria is near the surface, invariably preventing the patient from sleeping. This acute pain was probably due to pressure on the nerve endings by the ova laid by the female.

On the evening before consulting me, Mrs. M. stated that she was sure she would have a worm in her eye the next morning, and on waking found a swelling under the upper lid. As their presence in the eye is very transitory, she was brought to me at once and on examination the lids were seen to be slightly discoloured and swollen, while the bulbar conjunctiva was markedly oedematous, and a small localised swelling was seen in the upper and outer quadrant,

irregular in character, resembling a worm under the conjunctiva, and to the touch an enlarged vein as found in a varicocle. This was anaesthetised with 5 per cent. cocaine, a speculum inserted and the worm firmly grasped with a pair of forceps. The conjunctiva was dissected backwards from the limbus until the worm was exposed and finally removed. The conjunctival flap was stitched back in position, and a pad and bandage applied.

On macroscopic examination, the filaria was seen to consist of a short body and a long spiral tail measuring in all 10 mm. The tail was about twice as long as the body, which was more opaque than the colourless tail. The whole organism resembled a small piece of fine fishing gut. Unfortunately the specimen was destroyed before any microscopic examination could be made.

A fairly acute reaction followed the removal of the filaria, a mucopurulent conjunctivitis supervening, but this quickly yielded to treatment, leaving an indurated area at the site of the operation.

The second filaria has made itself manifest since by swellings in the ankle and right elbow and right index finger, giving rise to marked swelling and great pain, but so far has not appeared in either eye.

In all probability the swelling is due to the deposit of ova in the lymphatic system as occurs in elephantiasis, but this is only conjecture on my part.

Yours truly,

A. BECK CLUCKIE.

BATH.

NOTES

Death

AS we go to press we learn with profound regret of the death of Mr. J. Herbert Fisher. We hope to publish a memoir in our next issue.

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Cours de Perfectionnement, 1933

THE Annual *Cours de Perfectionnement* will be held in the ophthalmic clinic of the Faculté de Médecine de Paris at the Hôtel Dieu from May 5 to June 2, 1933. Professor Terrien, assisted by numerous helpers, will be in charge. The *cours* will be divided into two

sections, viz., clinical and laboratory, and ophthalmic surgery. The fee for the course has been fixed at 300 francs, for each section. Further particulars can be obtained from Professor Terrien.

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The Sight-Saving Review

THE Sight-Saving Review, Vol. II, Nos. 3 and 4, September and December, 1932. (Published quarterly by The National Society for the Prevention of Blindness, Inc. U.S.A.)

The third number of the second volume of the Sight-Saving Review contains an article by Dr. Luther C. Peter on "Facts and Fallacies concerning Squint." The author of this paper addresses his remarks to lay people and describes the common misconceptions about squint and the prejudice of parents against glasses and operative measures. He outlines the approved methods of treatment and urges that this should begin before the sixth year and preferably before the third year of life, at which period the results of treatment are good.

Winifred Hathaway in a paper on "Curriculum Problems in Sight-Saving Classes," describes the methods of instruction to visually handicapped children so that their education may progress parallel with that of normal sighted children and later they may be able to take their place in high schools and colleges. The radio, typewriters and other modern devices are of great help in conserving eyesight. Opportunities for creative work in art and music are given to such children and their physical education is carefully supervised.

Park Lewis has contributed a paper about "Nutrition in Relation to the Eyes" and deals particularly with vitamin deficiency as an aetiological factor in night-blindness, xerophthalmia, keratomalacia and other diseases.

The causes of preventible blindness are described by F. H. Rodin. Illumination problems are dealt with by Louis Resnick.

Vol. II, No. 4, of the Sight-Saving Review contains an article by John M. Wheeler on "Cataract—Its relation to Medical Social Work." His remarks are addressed to Social workers. He describes the clinical varieties of cataract and their prognosis, the indications and contra-indications for operative treatment and the results of such treatment. Prophylactic work is stressed particularly in regard to the prevention of congenital cataract by pre-natal care and to protection against heat, glare and perforating wounds in industry.

J. Guy Jones in his article "The Eye Physician in Industry" gives an account of types of industrial eye injuries, their prevention and compensation. The eye physician's duties must extend beyond

the rendering of prompt and skilled attention to the injured workman. He is also agent for the employer and the insurance company and should guard against unjust and excessive claims. Through tact, discretion and fairness he should secure the confidence and co-operation of all parties.

Professor F. de Lapersonne has contributed a paper on the prevention of blindness. He stresses the fact that the majority of those who are blind need never have been so. Simple hygienic and mechanical measures, within the reach of everyone are enough to prevent this.

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Examination of the Eyes of Industrial Employees—Why and How?

EXAMINATION of the eyes of industrial employees—why and how? Address by Dr. M. Davidson, Ophthalmologist, New York State Department of Labour. Greater New York Conference.

Dr. Davidson in his address before the Greater New York Safety Conference on March 1, 1933, puts forward four fundamental reasons for the eye examination of industrial employees. The first and second, safety and medico-legal problems in workmen's compensation, are of public concern whilst the third and fourth, industrial selection and vocational guidance, are in the interest of industry and the worker respectively. In assessing defective vision, the different visual elements, acuity, colour and light sense, indirect vision and depth perception should be specified.

A standardization of the visual requirements for aviators, seamen, railway engineers, public motor vehicle drivers and private owners of cars, for form, orientation, light and colour senses and binocular vision is given in a table.

Psychological tests such as the reaction time, sense of responsibility and other factors of importance are omitted from the table as they belong to another field of investigation.

Dr. Davidson points out that a great deal of unnecessary litigation and occasional incentive to fraud could be eliminated if there were records of an ocular examination of the employee at the start of his employment. Controversies in court about old and new injuries, traumatic and non-traumatic conditions and congenital and acquired diseases would be then eliminated to a large extent and miscarriages of justice become less frequent. The interval between re-examination of the employee's eyes is recommended as three to five years. An ophthalmologist trained in this work could examine about 50 persons a day and 10,000 a year.

The visual standards required for certain types of occupation should be worked out on different bases for the purpose of selecting employees, vocational guidance and the elimination, as far as possible, of occupational diseases.

Publicity in Ophthalmology

THE American Foundation for the Blind and the National Society for the Prevention of Blindness have issued a statement concerning the false hope aroused in many of the blind, their relatives and friends by the widespread newspaper publicity in the United States announcing that telescopic spectacles are so perfected that 40 per cent. of the present classified blind population now enjoy restoration of vision.

These two organizations have stated that in the experience of ophthalmic surgeons the true percentage of these persons, now classified blind, who can receive visual assistance from telescopic lenses is not 40 per cent. but less than 5 per cent., and that many of these are unable to use the lenses in their daily occupations because of limitations in the visual field when wearing the lenses, distortion effects, movement of objects on turning the head, the weight of this optical device and the impossibility of using the same lenses for the requirements of both distant and near vision.

There is no "great discovery" in the use of magnifying glasses for spectacles, for the first attempts to improve vision by applying the magnifying principle of the telescope to spectacles were made about 300 years ago and for more than 20 years ophthalmic surgeons have prescribed telescopic lenses for selected cases in their practice.

The introduction of a cylinder into these lenses is no "new development" as the newspapers would have the public believe and indeed does not produce any real improvement, for in some instances objects appear to be closer than they are actually and the images are blurred and distorted.

It may be the intention of certain newspapers to keep abreast with scientific advances and where such are believed to be of benefit to the afflicted to proclaim the news widely, but frequently the information given to the public through such channels is incorrect and warped by the imagination of its writer. The absence of a balanced scientific assessment of the value of some therapeutic advance leads to a departure from the truth about its worth and thus produces, by the disillusions that follow, further misery to those whom it is alleged to benefit.

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Corrigendum

MR. MAYOU points out that in the Returns for St. Margaret's Hospital for Ophthalmia Neonatorum, the word "born" should have been deleted from the last line on page 253.

North of England Ophthalmological Society. Officers for Session 1933-34

AT the Annual Meeting of the Society the following members were elected to the Council for the Session 1933-34:—*President*, Mr. D. Matheson Mackay, Hull; *Vice-President*, Mr. Peter Macdonald, York; *Members of Council*, Mr. C. F. Eminson, Doncaster, and Mr. D. Stenhouse Stewart, Hull; *Treasurer*, Mr. W. H. Kiep, Bradford; *Secretary*, Mr. Percival J. Hay, Sheffield.

FUTURE ARRANGEMENTS

1933

May 11-13.—Ophthalmological Society of the United Kingdom, Annual Congress, at the Royal Society of Medicine.

May 26.—Midland Ophthalmological Society, at Gloucester Royal Infirmary.

June 9.—Royal Society of Medicine, Section of Ophthalmology (Annual Meeting).

July 5-8.—Oxford Ophthalmological Congress, at Oxford.

October 6.—Midland Ophthalmological Society, Annual Meeting, at Birmingham and Midland Eye Hospital.

December 5.—Midland Ophthalmological Society, at Birmingham and Midland Eye Hospital.

CONTEMPORARY OPHTHALMIC LITERATURE

American Journal of Ophthalmology. *March, 1933.*

MONCRIEFF, COULTER and HOLMQUEST. Experimental studies in diathermy applied to the eye and orbit.

BERENS, CONOLLY and KERN. Certain motor anomalies of the eye in relation to prescribing lenses.

KRAUSE. The chemistry of the sclera.

HOWARD. Results of recent investigations in the aetiology of trachoma.

WRIGHT. Details of cataract extraction.

MERRILL and OAKS. Extreme bilateral exophthalmos.

Archives of Ophthalmology. *March, 1933.*

KATZ. Total and complete keratoplasty with a conjunctival flap.

JAMES. Degeneration of ganglion cell following axonal injury: an experimental study.

FERREE and RAND. Lighting without glare: a further contribution.

MAYER. Visual fields with minimal light stimulus.
WILMER, PIERCE and FRIEDENWALD. The light streaks on the retinal blood vessels.
BEIGELMAN. Reticular fibres in some hyperplastic diseases of the conjunctiva.
RADOS. Traumatic epithelial cysts within the eye.
MEDING. Foreign body in orbit; foreign body in anterior chamber; ulcus serpens: noteworthy cases.
PILLAT. Physiologic content of pigment in the conjunctiva of Chinese: some remarks on normal and on pathologic pigmentation.
BURKY, WOODS and WOODHALL. Organ specific properties and antigenic power in homologous species of alpha crystallin.

Annales d'Oculistique. *February, 1933.*

KALT. Congenital hydrophthalmos. Anatomical considerations.
SIEGRIST and CRAMER. About a case of bilateral cancer of the uvea, secondary to a primary carcinoma of the lung.
SHIMKIN. Contribution to the symptomatology and diagnosis of tumours of the stalk of the pituitary gland from the ocular point of view.
TERSON. Technique of enucleations with neurectomy.
ABRAMOWICZ. Examination by the diaphanoscope for Charles Bell's sign.
——— A new procedure for the determination of the correct cylindrical lenses by the help of the Javal-Schiötz ophthalmometer.

Annales d'Oculistique. *March, 1933.*

ROCHON-DUVIGNEAUD. The chameleon's eye.
RISCHARD. Parasympathetic poisons and accommodation.
DUFOUR. On the theory of correct glasses giving exact images.

Archives d'Ophtalmologie. *March, 1933.*

ROLLET. Keratitis, degeneration and corneal opacities, hereditary and familial.
VILLARD and DEJEAN. Cysts of the iris.
ALEXIADÈS. Bridled tenotomy.
TERRIEN. Remarks on the limitations of tenotomy.

Revue d'Oto-Neuro-Ophtalmologie. *January, 1933.*

COLLET. Statistical study and aetiology of anosmia.
HEYNINX. The physiology of smell.
WEILL and NORDMANN. The calibre of the pupil in homonymous hemianopia.
PORTMANN and DELMAS-MARSALET. On certain features of labyrinthine reactions in three cases of traumatic temporal lesions.
SOUCHET and LACROIX. Retro-bulbar neuritis, diplopia, with signs of frontal sinusitis. Intervention. Absence of sinusitis. Cure.

Klinische Monatsblätter für Augenheilkunde. *March, 1933.*

LINDNER. The recovery of form in detachment of the retina.
FUCHS. Oedema of the corneal epithelium.
BIETTI. Cup-shaped proliferation of whole uveal tract with participation of the orbit. Simultaneously a contribution to the clinical features of leukaemia, lymphadenoma and lymphosarcoma of the eye.
FLEISCHER. Febrile treatment of tabetic optic atrophy.
SPRINGOVITSCH. On the results of treatment of optic atrophy with retro-bulbar atropine injection.
BUSACCA. Sulphur treatment of syphilitic optic atrophy and other eye diseases
CUSTODIS. Contribution to the pathology and treatment of cysts of the iris.

FRIEDE. The removal of a non-magnetic foreign body from the vitreous.
KREIKER. Complete covering of the cornea by conjunctiva as a remedy for rodent ulcer of the cornea.
MOTEGI. A study of one species of micro-organism in trachomatous tissue.
SOBANSKI. On the negative readings of Schiötz tonometers.

Zeitschrift für Augenheilkunde. *March, 1933.*

GEBB. Gonin's Ignipuncture.
WATZOLD. On the question of emergency operations for serious accidents with particular regard to the after effects in the injured eye.
KREIBIG. A rare case of neurogliomatosis in the choroid.
CASANOVAS. A study of atypical scleral rupture.
VON CHAN and MERRILL. A peculiar hole of the retina and choroid inthe macular region.
MEISSNER. Oculists to the blind institute.

Annali di Ottalmologia e Clinica Oculistica. *September, 1932.*

D'OSVALDO. Visual acuity in a failing light.
LARICCHIA. A clinico-histological contribution to lymphangioma of the bulbar conjunctiva.
PAPAGNO. Exophthalmos pulsating spontaneously with arterio venous aneurysm of the internal carotid and cavernous sinus.

Archivio di Ottalmologia. *November-December, 1932.*

FERRARI. Tonometry and tonoscopy in pregnancy, labour and puerperium.
ROSSI. Disturbed retinal circulation in epilepsy.
BARDANZELLU. A new method of surgical treatment of subcutaneous angiomata of the face.

Bollettino d'Oculistica. *March, 1933.*

MARCHESINI. About a case of anophthalmos and microphthalmos with iris coloboma, A contribution to the knowledge of congenital malformations of the eye.
BOSSALINO. Intermittent spontaneous bilateral dislocation of the lens into the anterior chamber. (Clinical and slit-lamp contribution.)
GIOTTI. On the prismatic effects of decentration of spectacle lenses.
LUGLI. Recurrence of epibulbar endothelioma with orbital manifestations.
BUSSOLA. Anatomical alterations in the myopic eye and their importance in the genesis of progressive myopia.

Archivos de Oftalmologia Hispano-Americanos. *March, 1933.*

MOREU. Gold salts in ocular therapeutics.
VIDAUR. Something about serous meningitis.
ROS. Parenchymatous keratitis.

Anales de la Sociedad Mexicana de Oftalmologia y Oto-Rino-Laringologia.

ESTRADA. Improved technique in dacryocystorhinostomy.
BAILLIART. Movements of the tonometer indicator.